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RAILWAY ENGINEERING AND MAINTENANCE OF WAY

New Series, Vol. XII
Old Series, Vol. XXX
No. 3
MARCH
1916

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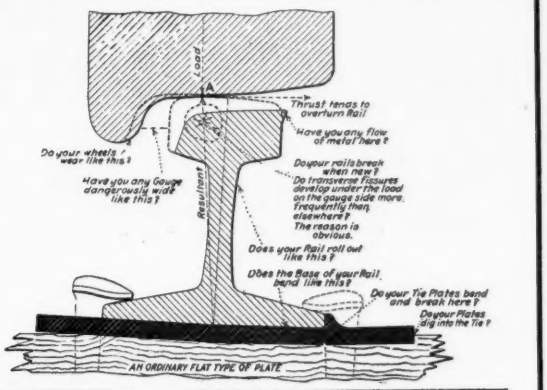
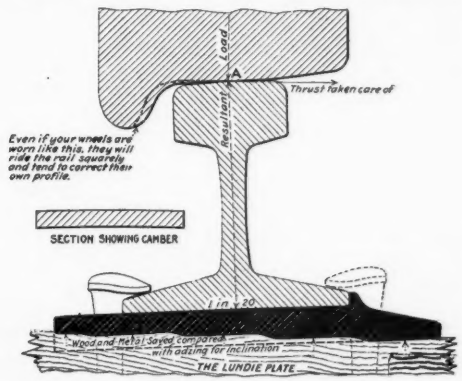
MODERN SCIENTIFIC TIE PLATE PRACTICE

HAVE YOU ANY RAIL APPROACHING THIS CONDITION?


Load
Thrust tends to overturn Rail
Have you any flow of metal here?
Do your wheels wear like this?
Do your rails break when new?
Have you any Gauge dangerously wide like this?
Resultant
Do transverse fissures develop under the load on the gauge side more frequently than elsewhere? The reason is obvious.
Does your Rail roll out like this?
Does the Base of your Rail bend like this?
Do your Tie Plates bend and break here?
Do your Plates dig into the Tie?
AN ORDINARY FLAT TYPE OF PLATE

WHY NOT USE THE LUNDIE TIE PLATE AND PRESERVE YOUR RAIL LIKE THIS?


Load
Thrust taken care of
Resultant
Even if your wheels are worn like this, they will ride the rail squarely and tend to correct their own profile.
SECTION SHOWING CAMBER
1 in ¥ 20
Wood and Metal Sayed compared with adzing for inclination
THE LUNDIE PLATE

THE LUNDIE TIE PLATE

A SAFETY DEVICE — AN ECONOMIC DEVICE

THIS PLATE WILL PAY FOR ITSELF IN SAVING OF RAIL AND WHEEL WEAR ALONE. IT IS MUCH MORE THAN A MERE TIE PLATE.
COMPARED WITH AN ORDINARY FLAT PLATE IT HAS THE FOLLOWING FEATURES:—

SAFETY

It will minimize tendency to accident by so-called track spreading.
It will reduce internal stresses in the rail, so tending to eliminate rail fractures.

ECONOMY

It will give rail over thirty per cent. longer wearing life.
It will give wheels a similar increase in life.
It will hold the gauge, and so save maintenance expense in re-gauging.
It will not injure the fibre of the tie.

EASY RIDING

It will present an adjustable bearing to the base of the rail as a wheel load passes over it, owing to the camber.
It will not rattle.

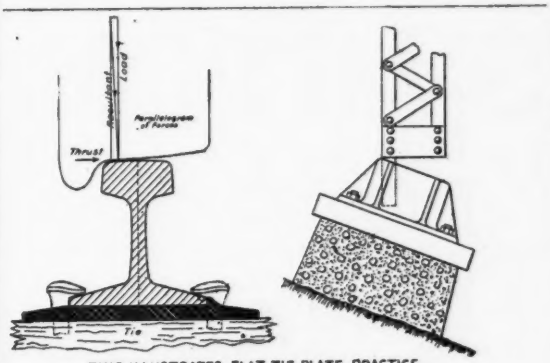
COST

It is not simply a flat piece of metal with holes punched in it and thus cannot be compared with other plates on a price per pound. For equivalent efficiency, however, it compares favorably in price per plate with any other tie plate on the market.

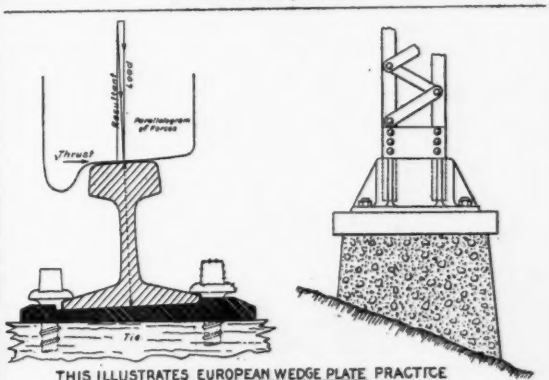
The Resultant Force, due to a wheel load on a rail and the wedging action of the coning of the wheel, is at right angles to the direction of this coning.
This Resultant is the force bearing from the wheel on the rail, independently of the necessary "nosing" action of the wheel flange on curves.

In the diagrams shown below, the bearing of the wheel on the Rail, Tie Plate and Tie is compared with the load acting between a Steel Column resting, through a Shoe and a Masonry Foundation, on Sloping Rock. The column load is vertical, while the bearing of the wheel on the rail is at an inclination of one in twenty. The track sketches are to scale, while the foundation sketches are exaggerated to emphasize the point made.

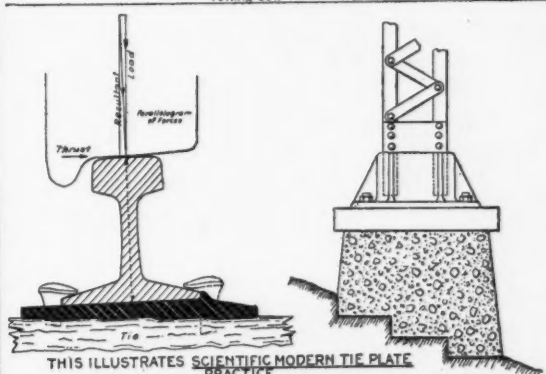
The Wheel corresponds to the Column
" Rail " " Shoe.
" Tie Plate " " Masonry
" Tie " " Sloping Rock



THIS ILLUSTRATES FLAT TIE PLATE PRACTICE.
Rail and Plate tend to "roll out."



THIS ILLUSTRATES EUROPEAN WEDGE PLATE PRACTICE
Note the heavy bolts required to keep the plate from "rolling out."



THIS ILLUSTRATES SCIENTIFIC MODERN TIE PLATE PRACTICE.
The Seating of the plate is normal to the resultant force bearing on it. The Plate will not "roll out" from the resultant force shown, but will hold the track to gauge

In addition to being seated at right angles to the resultant of the forces acting on it, the Lundie Tie Plate is cambered lengthwise to the rail, so permitting the rail to travel over the surface of the plate with a gentle flexing motion as wheel loads approach to and recede from it, giving smooth riding track. With a flat plate, the rail, under approaching and receding wheel loads, tilts the plate by coming in contact with its edges, so inducing rocking ties and rough riding, clattering track.

New Wheels and Rail over The Lundie Tie Plate will tend to retain their standard contours. Worn Wheels and Rail over the Lundie Tie Plate will tend to return to their standard contours

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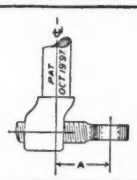
CRANK ADJUSTMENTS FOR RAMAPO SAFETY SWITCH STANDS

THROW OF STAND	"A"		THROW OF STAND	"A"
3½"	2 11/16"		4½"	3"
3⅝"	2 7/8"		4⅝"	3 3/16"
3¾"	2 15/16"		4¾"	3 5/16"
3⅞"	2⅞"		4⅞"	3 7/16"
4"	2 13/16"		4⅞"	3 11/16"
4⅛"	2 11/16"		4¾"	3 7/8"
4¼"	3"		5"	3 11/16"

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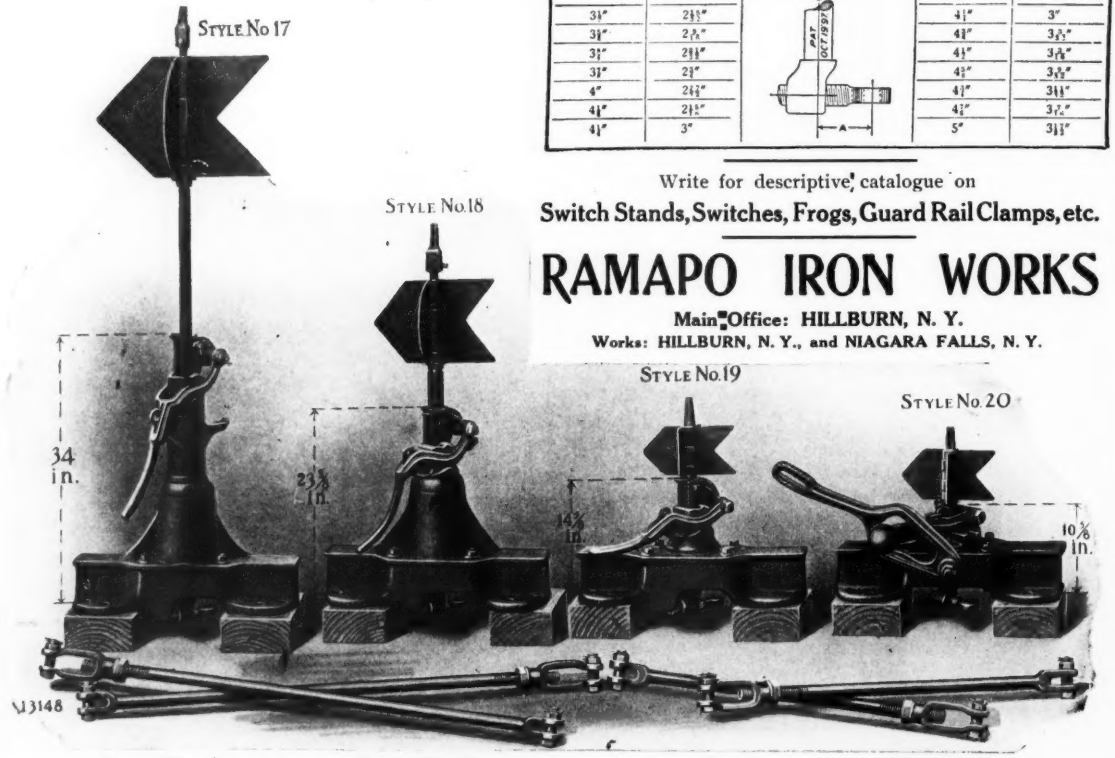

STYLE No. 17 STYLE No. 18 STYLE No. 19. STYLE No. 20

RAMAPO PATENT SAFETY SWITCH STANDS

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY
WITH WHICH IS INCORPORATED ROADMASTER AND FOREMAN

New Series Vol. XII
Old Series Vol. XXXI | *Established 1884* | NEW YORK, MARCH, 1916 | *Copyright 1916* | No. 3

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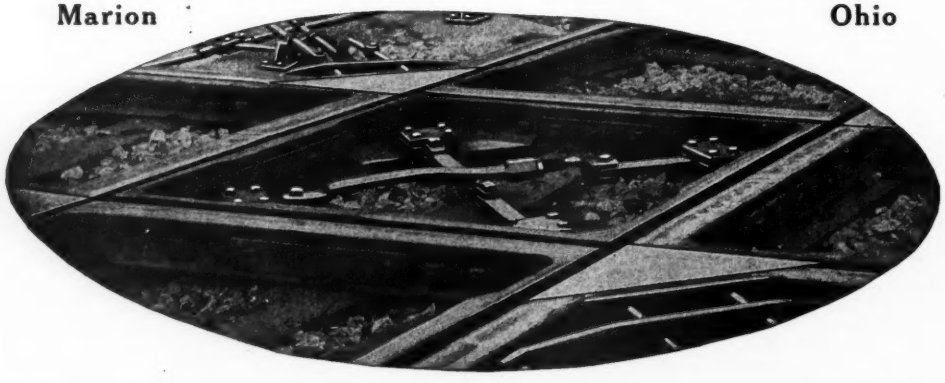

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The Growth of the Convention Idea

The history of conventions of railroad and railroad supply men in this country is a history of accomplishment and progress. In the early days, the social feature of the meetings of railway associations seems to have predominated. Gradually the power of the association toward standardizing the varying practices in separated parts of the country was recognized, and the value of some of this work is second in importance only to such measures as adopting standard gauge. The serious work done by the associations has entitled them to the respect and influence which they enjoy. This respect and influence, once earned, has reacted to make the subject matter and discussions at their meetings of increasing pertinence and value.

Just as there has been progress among the railway associations, there has been an appreciable movement among the associations of railway supply men toward serious accomplishment. The beginnings of all the representative associations of railway supply men can be traced to entertainment of railroad men attending railroad men's conventions. The early forms of exhibit—models in the parlors of hotels where railroad men met—were the beginning of the educational idea, which has been fostered, until in its present proportions it is a mighty force in the advancement of the science of transportation.

The educational value of a convention which brings together working models of the most improved appliances entering into the work of a single department of railroad activity has been recognized. The convenience and economy of collecting under one roof tangible and demonstrable evidences of the scattered pioneer work of each year, where they may be examined and considered, has been admitted. The advantages of having these exhibits demonstrated and explained by qualified experts has been considered. The cost in dollars and in time of preparing and concentrating the exhibits and of assembling the railroad men and supply men has been estimated and appreciated.

The railroad and railroad supply men who attend the conventions know that a high degree of application and perseverance is necessary if full advantage is to be taken of the opportunities afforded by the convention. The subject of "Making the Convention Pay" has been considered recently in these columns. The preparation for the convention by both railroad and supply men has been discussed. To the men who attend the convention there remains less to be said than to the railroad men who do not attend; to the men who remain on the job, keeping the wheels going 'round, while their associates or subordinates, as the case may be, are delegated to attend the convention, absorb and assimilate the information it offers, and bring back, to the extent of their ability, the convention itself.

It is unfair to the men who are sent to attend a convention to even imply that such a trip partakes of the nature of a vacation. True, it brings a change of work, which might ordinarily be considered as more or less refreshing; but in reality it places under such a strain the man who takes seriously his responsibilities in representing his department at the convention that any restful effects resulting from changed surroundings are more than overcome by the concentration required, the long and irregular hours imposed, and the unnatural mental and physical stimulation incident to these conditions. A man's attendance at a convention must be regarded as seriously as any other trip of investigation on behalf of his railroad, if the man is to feel the sense of responsibility that is necessary to the fullest realization of the benefits of the convention.

In this connection, a word in behalf of the railroad supply companies is not out of place. Only such railroads as have themselves gone through the experience of preparing an exhibit for their own purposes are in a position to intelligently appreciate the effort and expense involved in preparing suitable exhibit material, and bringing together the corps of experts necessary to adequately describe and demonstrate the material exhibited. In return for the convenience afforded by this gathering together of men and material, the exhibitors deserve systematic and serious consideration of their exhibits. Only by such earnest of appreciation are they warranted in making their present efforts to be of service in this way.

The March conventions in Chicago afford the best present example of the combination of serious work done by railroad associations, serious preparation of exhibits of pertinent railway supplies, and serious attention given by the railroad men to the appliances of the supply men. The sentiment in favor of this attitude toward all technical conventions is reaching gratifying proportions. It is within the power of every man who takes the trip to Chicago this year to add to the value and importance of the convention idea by adopting the proper attitude toward his work at the convention.

What-Some Railroad Necessities Cost

The New York Central has recently prepared some interesting data relating to its own lines and service which will apply in a general way to many other systems. The practically stationary rates, both passenger and freight, and the steady increase in the cost of operation are the basis for the preparation of these interesting figures.

In the past ten years the New York Central has expended $400,000,000 for new stations; electrification; the separation of grade at highway crossings; safety devices of all kinds; rock ballasting; heavier bridges; heavier locomotives; coaches and equipment of various sorts, and all this in the interest of the public good. Wages of train employes alone have advanced 45 per cent in the last decade. Supplies of all kinds have steadily increased in prices in the same time. In the matter of equipment alone there have been some tremendous increases. Steam locomotives formerly costing on the average $17,300 each, are now to be had at $25,000, while electric locomotives have gone up in price from $30,000 to $50,000. Seven years ago steel passenger coaches could be purchased for $12,000 each. Today $16,000 is the standard figure, and within three years the price of a steel baggage car has advanced from $8,000 to $8,800—an increase of 10 per cent. Additional heavier equipment has forced the company to rebuild its roadbed; construct more substantial bridges and culverts and lay heavier steel rails, while the consumption of fuel has greatly increased on account of the larger engines in service.

Eight years ago steel rails cost $29.30 per ton. In 1914 the price was advanced to $30.02 and today it would be impossible to secure them at this figure. The standard weight of rails, of a few years ago—85 lbs. to the yard—has been abandoned, so that now requirements call for a 105-lb. pattern, or, as in many instances for a 140-lb., in order to safely handle the increased weight of equipment. By the M feet, ties cost $21.64 in 1910. Today the price for the same class of material is $24.64 per M feet. The vast quantities of stone ballast required, formerly purchased at 60 cents per yard, now cost 65 cents. The cry for "safety first" and efficiency has resulted, too, in enormous expenditures in the way of improved signal systems. What are classed as "current improvements" have increased $4,000,000 since 1910. Not including the vast outlay in the Grand Central terminal, these current improvements aggregate $39,000,000 for the past five years. Electrification work beginning in 1903 has involved an outlay of $24,000,000. These are all most interesting facts, not to mention an increase in taxes of more than $1,250,000 since 1910.

It is no wonder that a desire for better rates is encouraged on the part of this and other great railroad systems. The New York Central refers to the present rates as "ancient" and most of them truly are. All outgo and no income is much harder on a railroad than overwork on the boy who does not remember that "all work and no play makes Jack a dull boy."

Extra Professional Duties of an Engineer

As a general definition of the word engineer it has been said that he is a man who has helped to bring about many wonderful developments in utilizing the forces of Nature and by so doing he has increased the efficiency of each worker many fold. It might be added that he has added to the material comfort of millions and has given to life a wider and more satisfying outlook. It has been said that an engineer is a "dreamer whose dreams come true."

In presenting a paper to the A. S. M. E. not long ago, Mr. F. H. Newall drew the generally accepted and conventional picture of the engineer when he described him as one who, to the ordinary public, appears as a man seated in his office, perhaps removed from interruption, absorbed in abstruse calculations, and unaware of the changes going on outside in other lines of endeavor. If this is true, as no doubt it is, in part at least, the engineer fails to receive the recognition from the public to which he is justly entitled. He is a conscientious worker and usually possesses a great deal of modesty, so much so that he does not concern himself with the task of enlightening the public. He may regard that as the legitimate work of others, but by not telling his own story a lack of recognition is his meed.

The engineer, unlike men in other professions, has to deal with elemental physical conditions. His success does not depend on convincing an audience, nor on directing or even leading the thoughts of his fellow men, whose opinion and belief are transitory. The engineer's work must be judged by higher and more rigidly exacting standards, for he deals with the forces of nature, which do not lie and cannot be deceived; he may not flatter, and he would browbeat them but in vain.

It has been said that the work of an engineer should speak for itself, but much of his best work is not visible, and even if it is conspicuous, it is often unobserved and seldom understood. Foundations of stupendous and imposing structures are buried deep. Tunnels, water works, sewers, processes, methods and appliances and many of the essentials of life produced by the engineer are out of sight. The information concerning these things may be read in the technical press or in the transactions of professional societies and clubs, but the man in the street does not read these accounts. Mr. Newell further charges that much that appears in the periodic press of the professions is highly technical, and is often only within the mental grasp of a few experts. Many of the technical papers read at society meetings are not presented so as to be readily taken in by the practical railway man, on whom rests the bulk of the actual performance of railway work.

It is true that to the technically educated man it is easier to write so as to reach the trained and well-informed few, but the necessity for simplication exists if the profession is to do all that is expected of it. Years ago Huxley, who was a trained and expert biologist, took up the cause of organic evolution as set forth by Darwin, and brought the subject to the level of the

ordinary intelligence, so that in the end his devotees practically embraced all who could read or think. Indeed, so completely was the difficult task of reaching so vast an audience accomplished that at the twenty-first anniversary of Darwin's book Huxley said that the theory of evolution had been so widely and completely accepted that a little healthy opposition would do it good.

Mr. Newell very rightly advocates the formation of local societies of engineers, and the vigorous prosecution of the work supposed to be done by them. In the railway world we have special societies, associations and clubs each of which publish proceedings, and the technical press of the country is doing much good work in spreading abroad the information gathered by experts in the various engineering lines.

It is not, however, only the presentation of ascertained facts, good as they are, that is all important. Facts pure and simple are like the tempting viands on the table, their enjoyment is another thing, but their assimilation produces the results upon which growth depend. The exchange of ideas, and the comments of an experimenter or worker, on the experience of another is one of the most potent factors in the progress of railroad men. Meetings such as are to be held in Chicago this month, with the exhibition of railroad appliances and the demonstration of their utility, must occupy a high place in the estimation of the railroad man as a means of acquainting himself with the most recent progress which has been made in the science of transportation, in which he is vitally interested and with the success of which he himself is intimately concerned. He does not have to study behind closed doors, but may mingle with his fellows and in the open; see, observe and make the labors and the industry of others his own.

—+—

Bridge Floors and Guard Rails

A very great source of danger to the floor of a bridge, and indeed to the whole structure itself, is that which may arise at any time by the derailment of a pair of wheels or a truck, on the bridge or before an approaching train reaches a bridge It is possible for a derailed truck under a car to be hauled safely across the whole length of a bridge, in spite of the very well-known tendency of the truck to become slewed. This, however, is not a chance one who has the care of the bridge would care to take.

A common form of protection is the placing of a couple of wooden stringers parallel to the rails and between them. Each stringer is placed a few inches from the gauge side of the rails, and is bolted through the bridge ties at short intervals. These longitudinal stringers are generally notched or gained so as to fit down over each bridge tie. This prevents what is called the "bunching" of ties in case a wheel became wedged between ties without a guard, and pushed the first tie and those in front of it, along, leaving a gaping hole behind and perhaps causing the pushed ties to mount on one another. Sometimes this guard stringer is shod on the wheel side with an angle-iron to protect the wood of the stringer. The wooden stringer is open to the objection that it weathers like all exposed pieces of timber, and in time splits or develops cracks.

A more effective protection against a derailed truck is afforded by a rail of lighter weight than the track rail and placed approximately where the wooden stringer is usually placed. This inside guard rail has been found to be effective in dealing with wheels which are off the track. It is usual to carry this pair of guard rails a suitable distance off the bridge, in the direction of train approach and to join their ends in a curved angle, something in outline like a long high gothic church door. The point can be made from an old frog, and the point is often depressed, and indeed it is desirable to do this, so as not to present a raised obstruction in case a brake rod, sand plank or other piece of the running gear had fallen and was dragging.

The distance to which the "shore" end of the guard rail should be carried depends on circumstances. The probable approach speed of the trains, the presence or absence of a curve at the approach, an ascending or descending grade, etc., are matters which have to be decided on the ground for each particular bridge. The pointed guard rails when properly placed are spiked to the track ties and to the bridge floor ties, and with smooth and unobstructed joints, are capable of guiding derailed wheels across a bridge with minimum damage to the bridge floor.

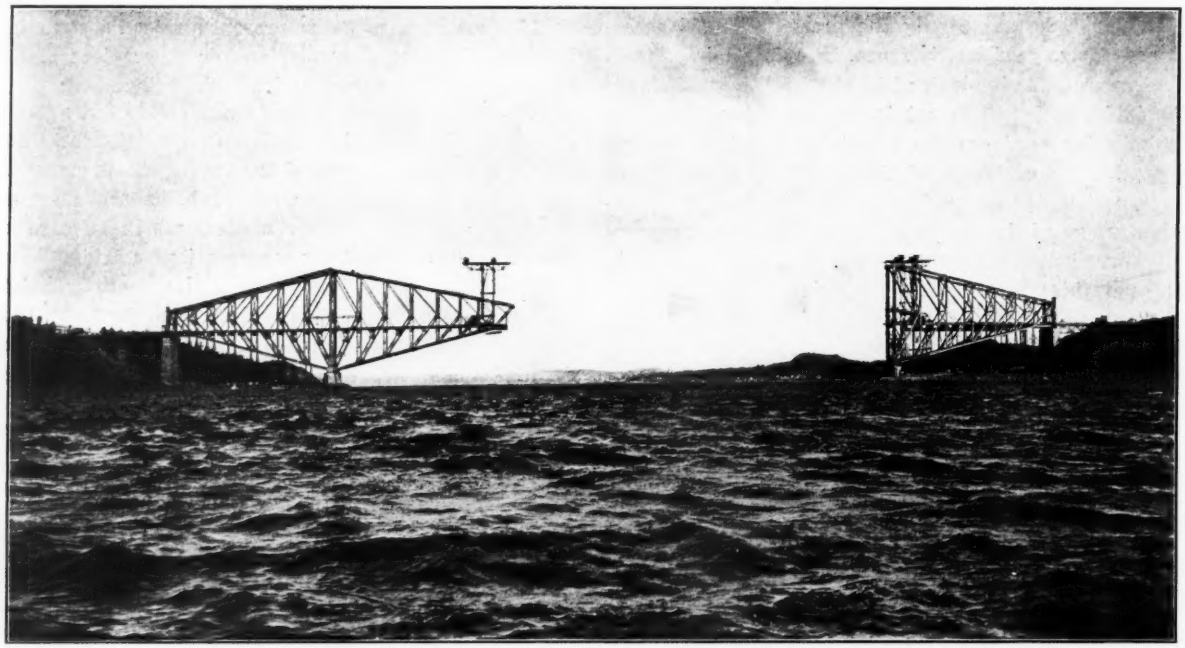
The guard rails perhaps do their best work when track rail and guard rail are each spiked to the same tie-plate on each tie. This necessitates the use of a long tie-plate, but the advantages secured are worth the cost. The standard gauge of track is 4 ft. 8½ ins. Rule No. 83 of the Master Car Builders' Code of Interchange Rules prescribes a distance of 4 ft. 5 3-32 ins. between the backs of car wheel flanges. That is, anything less than this, on wheels cast after 1908 are considered to be out of gauge. If the guard rails were placed 10 ins. or less if possible from the track rail, with a tie-plate under track and guard rail, and if the tie-plate measured, say, 25 ins. long, the derailed wheel between track and guard rails would roll over the tie-plates or probably run along the flange of the guard rail, with back of wheel against ball of guard rail, and have no tendency to slew.

The other wheel which had dropped down outside the track rail would be carried over each tie on the outside end of the long tie-plate, without any tendency to cut into the wood of the track ties. The size of the tie-plate to be used, and the weight of the guard rail per yard, and the position of the tie-plate, that is how far it was advisable to extend it outside the track rail, would all have to be decided by the engineer in charge, but this method of bridge protection against the effects of derailed wheels has in it the elements of at least one satisfactory solution of the problem, though its details would have to be adapted to the special conditions imposed on the engineer in charge.

The Largest Cantilever Bridge in the World

C. P. R. & N. T. R. Bridge Over St. Lawrence River, Piers 1,800 Feet Apart, Central Span 640 Feet Long. Weight of Bridge Approximately 65,000 Tons

The Canadian Government railway bridge near the city of Quebec, in Canada, when completed may be said to be the largest cantilever bridge in the world. The piers are 1,800 ft. apart and the suspended span is 640 ft. long. The bridge is expected to be in operation before the close of the present year. The work of spanning the St. Lawrence river at Quebec was begun about eight years ago and was a Government undertaking. It was conceived under the administration of the Liberal Cabinet, of which the Rt. Hon. Sir Wilfred Laurier was Premier. The first Government guarantee was for



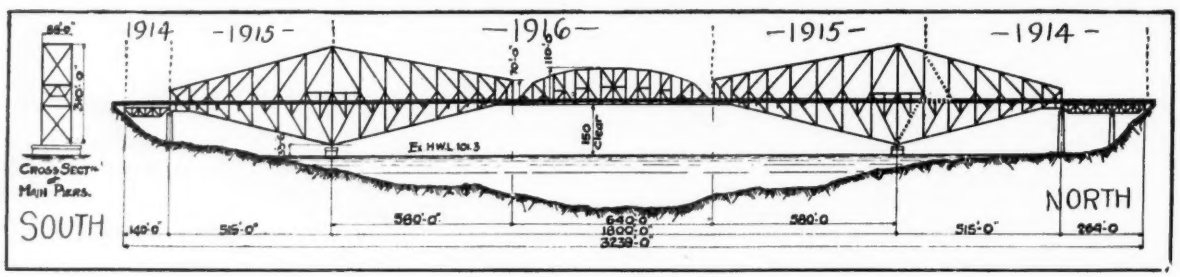
View of St. Lawrence River, Showing Work Done by End of 1915. North to the Left.

$6,000,000. This amount was then estimated to be sufficient.

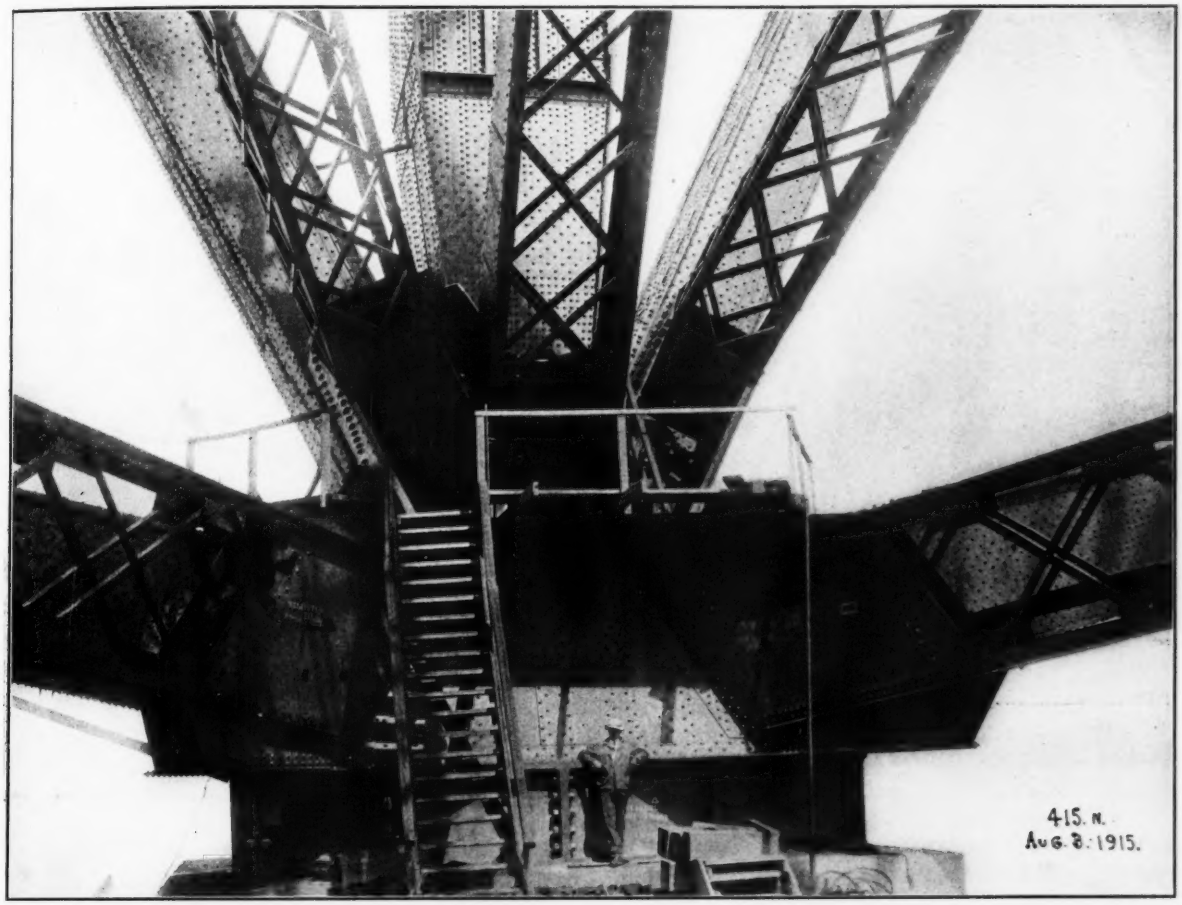
During the construction of the bridge thus begun, the structure gave way, entailing the loss of life of about ninety persons. The present bridge will cost $17,000,000 and will be the greatest example of the cantilever principle ever applied to any bridge. This form of bridge involves the construction of two long spans with piers under their centres and not at the ends, as in other types of bridges. A central or connecting span is hung between the free ends of each cantilever. These high members can be built out from the piers member by member on one side and then on the other, so as to keep the weight of the growing span properly balanced on the supporting pier. No scaffolding or false work is necessary where this method is followed and the navigation of the stream is not obstructed.

In many positions this system is the simplest and most economical method of bridging, and is often used for spans of greater length than where independent girders are used. The shore ends of the long cantilever spans are anchored down to piers or abutments, as the case may be, but the object of thus securing them is principally for the purpose of sustaining the weight of the rolling load when it comes upon the outer end of the cantilevers and where a suspended or connecting truss hangs to the free ends of each cantilever, the anchored shore ends will support the weight of the central span.

In the Quebec bridge the distance covered by two cantilever spans and the connecting span is 1,800 ft. These figures at once call to the mind the stupendous



Outline Sketch of Quebec Bridge, Showing Yearly Progress

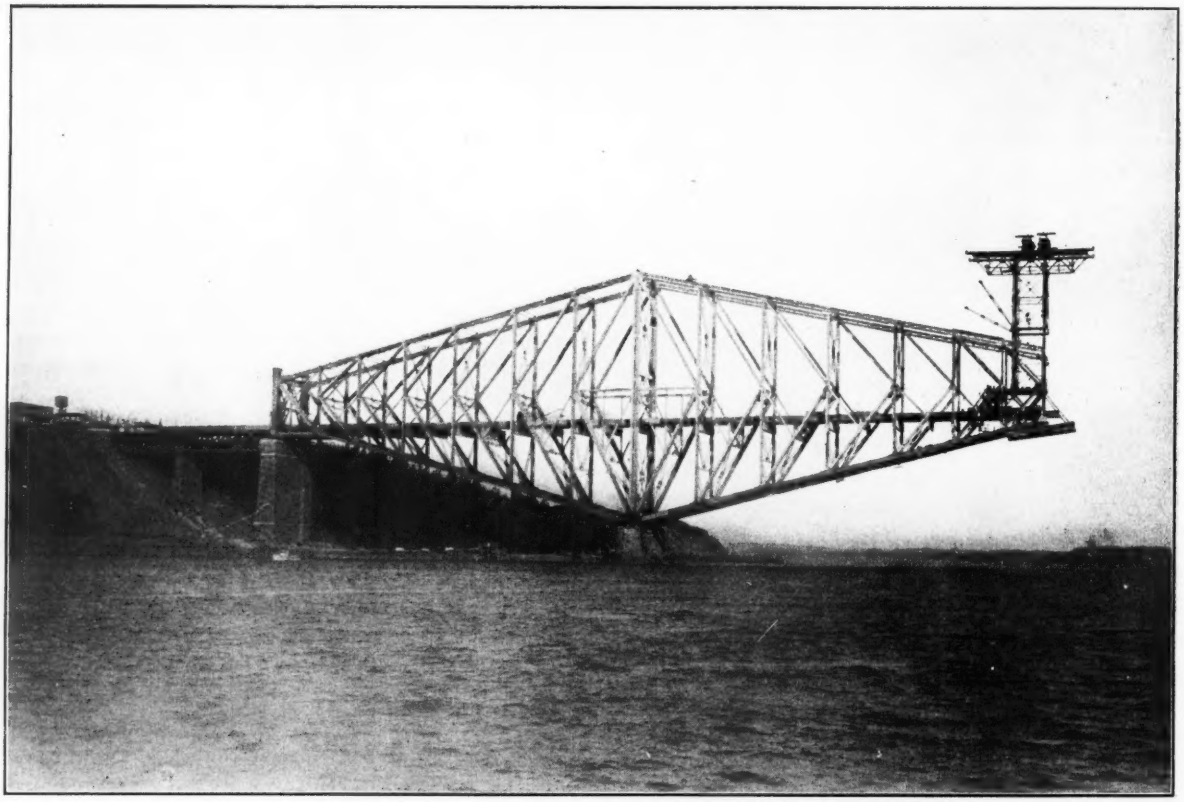


Ten Bridge Members Concentrated on the Shoe, the Reaction on Shoe Being About 55,000,000 lbs.

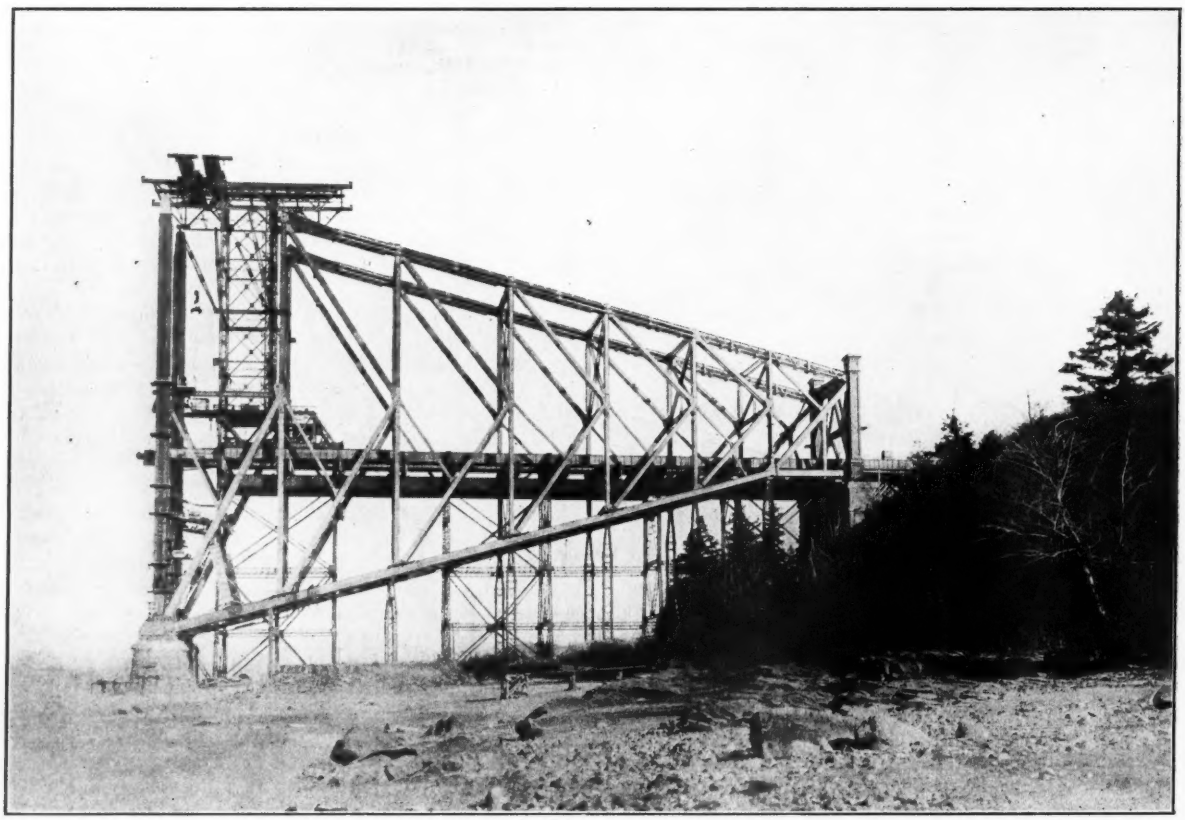
structure erected over the Frith of Forth by Sir Benjamin Baker. The Forth bridge has one tower on the island of Inchgarvie and it is 260 ft. wide. The distance between adjacent faces of the supporting piers is 1,710 ft., and this distance is exceeded in the Quebec bridge by 90 ft. The Canadian structure is being financed by the government and the C. P. R. will of course have running rights over it and also the government road, the National Transcontinental Railway. So closely do the anchor or shore end and the free end balance each other on the pier that there is only about 1,000 tons difference between them, the free end weighing about 24,000,000 lbs. and the shore end 26,000,000 lbs.

Here follows an account of the progress of erection of Quebec bridge up to and during season of 1915, by H. P. Borden, the assistant to the chief engineer of the bridge: When work on the Quebec bridge closed down in 1914, the north anchor arm was completed out to the main pier with the exception of two panels of the upper web members and top chord. On the south side no steel at all had been erected between the main and anchor piers.

About the middle of April, 1915, a start was again made on the erection of the steel on the north shore, and on May 3 of the same year the erection of the main posts was begun. These posts rest on the main shoes over the main pier and are the largest single members in the bridge, being 310 ft. high centre to centre of pins, and approximately 10 ft. square. As the four posts required for the bridge weigh approximately 6,000 tons, costing in the neighborhood of one million dollars, or considerably more than the entire cost of many important bridges, some idea of the magnitude of these members may be obtained. Each of these members is composed of four separate columns latticed together in four directions, terminated by a tapered solid section at both top and bottom. In order to facilitate shipment and handling, each of these members was shipped in twenty-six separate sections and spliced together in the field. It was expected that serious difficulty might be encountered in the erection of these sections as they had to be put in place with splice plates attached to the ends and lowered with extreme precision to allow the webs and flanges of the adjoining section to be entered between the various plates and angles forming the splice. The efficiency of the electrically controlled hoists on the erection traveler, however, was such that this work was carried out with remarkable rapidity, both posts on the north side being erected and riveted sufficiently to allow the traveler to be moved ahead within one month from the time a start was made. Enough riveting was done on these members to take care of all erection stresses before any further steel was erected or the traveler moved ahead. This riveting was considered highly advisable rather than filling the holes with bolts and drift pins and riveting later as the work progressed, as it was found from past experience that once a strain was applied to a drifted joint it was absolutely impossible to remove these drifts except by drilling. The cramped space in the interior of these members also made riveting somewhat difficult, but with the use of specially designed jam riveters, which could work in a space



View Showing Anchor and Cantilever Arms at North End



Progress of South Anchor Arm. Traveler Finishing South Main Post

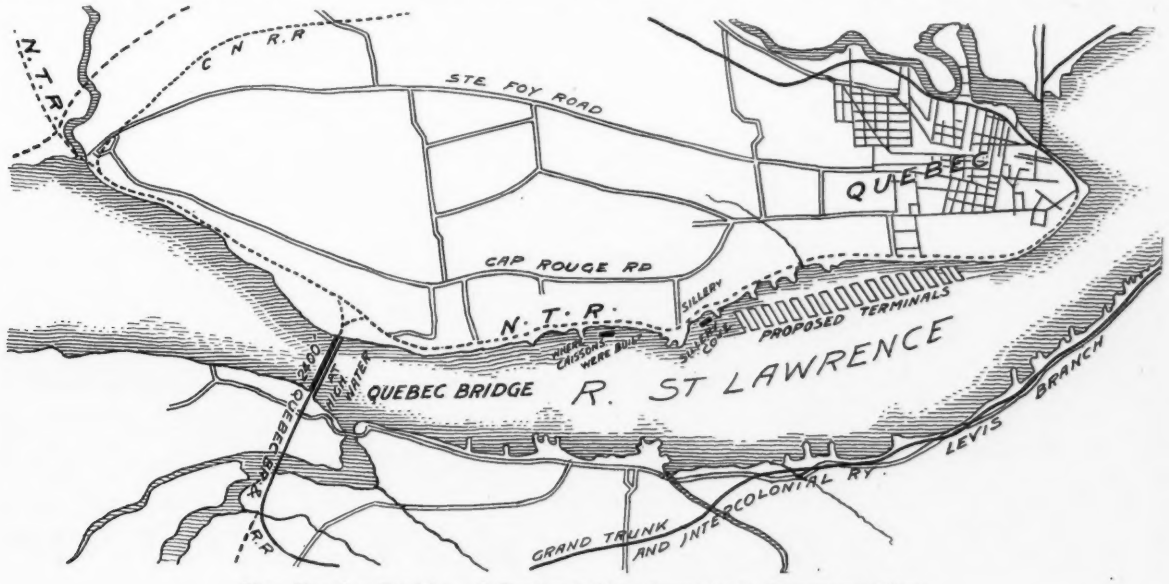
down to 14 in., very satisfactory work was obtained. While in some cases the heads of inside rivets were not perfect, yet, in all cases, tight rivets were obtained.

When the erection of the main post had proceeded to the desired stage, the traveler was moved ahead and the erection of the first panel of the cantilever arm was started. As the bottom chords have a field splice between main panel points, it was necessary to devise some support for these members for riveting this splice before it could be connected to the main panel point. This was accomplished by means of a "flying bridge" or heavy steel platform extending for one full panel length and for the width of the bridge. On this "flying bridge," which was supported by links to the structure above, the bottom chords were assembled and jacked up into their proper alignment, and the centre splices fully riveted up. As each panel was completed the "flying bridge" was moved forward to the next panel. This work went ahead very rapidly, as all field splices and connections had previously been reamed out in place at the shop, thus avoiding any shop errors or the necessity of making any alterations or changes in the field. As each panel was erected, accurate measurements were taken to see that the alignment was correct. Owing to the extreme accuracy with which this work was manufactured and inspected in the shop, no difficulty of this nature was encountered, the alignment of both the anchor and cantilever arms throughout their entire length being absolutely correct.

Members on both sides of the bridge were erected simultaneously by the traveling cranes and stiff-leg booms, and as the traveler moved ahead the sway bracing was put in position by the rear booms. Practically all splices in web members were riveted up complete before moving ahead, or at least sufficiently riveted, to carry the full erection stress.

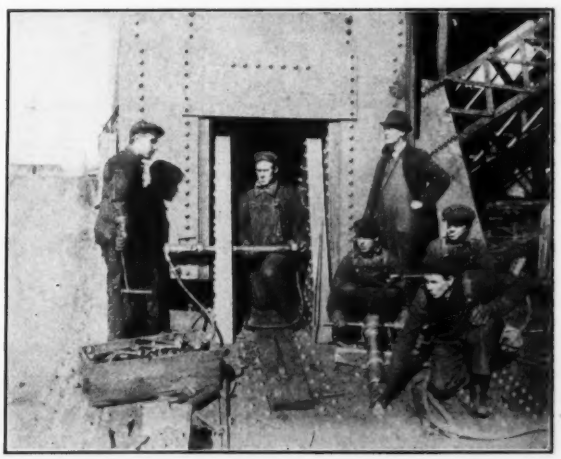
Remarkably good records were made in riveting, the percentage of rivets to be cut out being very low. In one case over 4,000 rivets were driven in the splices of the bottom chords, and only one loose rivet was found by the inspectors. This extraordinary record was due, naturally, to the experienced riveters employed on the work, but also to the fact that in reaming out the splices in the shop from 25 to 50 per cent of bolts were used in bolting up the splice material, thus preventing drillings getting in between the web plates of the member. When the splice was taken apart, care was taken to clean out all drillings that might be found to exist between any parts of the splice material.

By the middle of November, 1915, the cantilever arm was completely erected, being quite up to the programme laid out by the bridge company at the beginning of the season. The work of the traveler having been completed on this side of the river, it is now being taken down and will be re-erected at the site where the suspended span will be erected this year.



Map Showing Position of Quebec Bridge Over the St. Lawrence River

On the south shore the erection of the falsework to support the anchor arm was started about the middle of last April, this falsework being taken from the north shore where it had been used to support the north anchor arm. The erection of the anchor arm started on July 7, 1915, and, owing to the experience gained on the north side, it was erected much more rapidly, a gain of over six weeks being made in the completion of this work. By the middle of November, 1915, the entire anchor arm had been erected, including the main posts, with the exception of a certain amount of riveting, which will be completed this year.



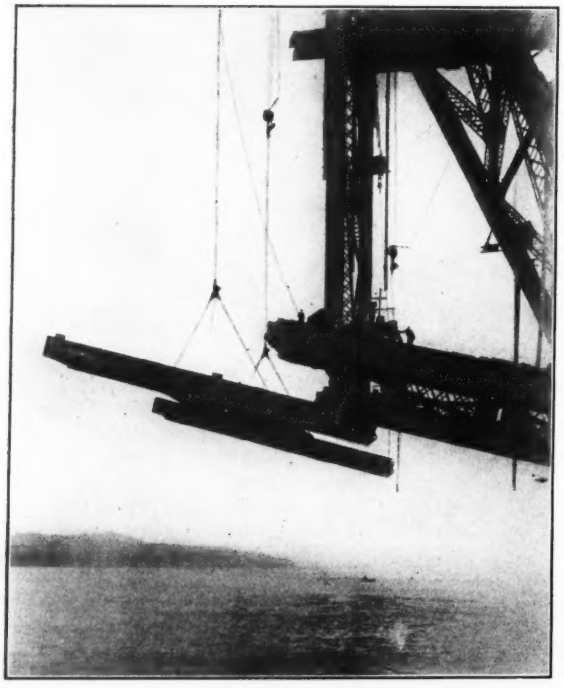
Workmen Riveting Members at Bottom Chord

During the past season about 30,000 tons of steel

were erected. In all about 45,000 tons have been erected out of the 65,000 tons, the estimated total weight of the bridge.

The record day's tonnage in 1915 was 670 tons for the south shore traveler, although there were several days in which over 600 tons were erected by this traveler. An average of 350 tons per day was made in the erection of the south main post.

Next season the south cantilever arm will be erected, and it is expected that this work will be finished early in September, 1916. The suspended span will also be erected at Sillery Cove, a point some three miles below the bridge site. When completed it will be floated to the site on six pontoons 160 ft. long and 32 ft. wide, each having a working draft of 8 ft. This span, which is 640 ft. long, 110 ft. high at the centre, 88 ft. wide, and weighing about 5,000 tons, will then be attached to



Flying Bridge Being Shifted

long hangers from the ends of the cantilever arms and jacked into place by means of heavy jacks placed on the erection girders at each corner of the cantilever arm. This operation should not take over twenty-four hours if everything works smoothly.

By the end of 1916 practically all the steel work of this bridge should be in place, and it will be possible for working trains to cross the river at this point.

The work is under the supervision of the board of engineers, Quebec Bridge, composed of Mr. C. N. Monsarrat, chairman and chief engineer, and Mr. Ralph Modjeski of Chicago. Mr. C. C. Schneider, a former member, is now deceased.

It may be mentioned that Mr. Monsarrat designed and constructed the Lethbridge viaduct, which is believed to be the longest and highest bridge in the world. It is on the line of the Canadian Pacific Railway.

The contract is being carried out by the St. Lawrence Bridge Co., Ltd., of which Mr. George F. Porter is engineer of construction; Mr. W. B. Fortune, superintendent, and Mr. S. P. Mitchell, consulting engineer of erection

The New German Railway Station at Leipzig

Railway Terminal of Sand Stone with Huge Iron Roof Nearly Half of Which is Skylight

U. S. Consul W. P. Kent, at Leipzig, has lately reported to the Board of Commerce at Washington that the large railway station was completed and put in service on December 1, 1915.

The total cost of the construction of the Leipzig station was $32,130,000. In meeting this expense, the amounts to be contributed are: By the Kingdom of Saxony, $14,280,000; by the Kingdom of Prussia, $12,614,000; by the city of Leipzig, $4,046,000; by the Imperial Postal Department, $1,190,000.

The main building, erected upon a symmetrical basis, has a front of 984.25 ft., and each one of the side wings measures 295 ft. The area covered by this main building is 167.918 sq. ft. The passenger platforms behind the main building are covered by an iron roofing of a length of 784.4 ft., and of a surface of 710,424 sq. ft. Of this roof surface, 301,392 sq. ft. are built as skylights. Above the passenger platforms are erected, side by side, six big arched trainways of a length of 787.4 ft. each.

The two outside halls have a breadth of 139.44 ft. each, while the four inside halls have, each, one of 147.64 ft. Each outside hall adjoins a smaller one of a breadth of 49.21 ft. Each of the first six halls is 65.62 ft. high, while the two smaller outside halls are only 32.8 ft. high. The total area covered by the main building and the passenger platform halls is 882,648 sq. ft.

The material used for the front of the building is a yellow-colored, hard sandstone from the quarries of Schona on the Elbe. The rear, and the walls of the big entrance halls, are built of sandstone of the Cotta quarries. The roofing is of tiles. The building was started in May, 1909. The cost, including that for the foundation work, amounted to $1,694,600.

As a connection between the main building and the passenger platforms, a cross hall has been established along the rear front, having a breadth of 114 ft. This cross hall again is adjoining toward the passenger platform by a cross platform of a breadth of 78.7 ft., thus enabling the passengers to pass from one platform to another without being hindered by the entering or outgoing of other travelers.

From the square in front of the building two big entrance halls, 85.3 ft. high and covering each a floor space of 18,083 sq. ft., lead over staircases 33 ft. in breadth to the cross hall above the street level.

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Cement and Concrete Specifications for Chile

A recent Commerce Report says that a set of standards and specifications for the cement and reinforced concrete used in Chile has been received by the Bureau of Foreign and Domestic Commerce. The standards for cement were compiled by a committee of technical experts and scientific men, who stipulated that the first requisite for the acceptance of any cement by the Government should be a certificate of approval from the testing laboratory at the University of Chile. Besides being subjected to chemical analysis at this laboratory, the cement is tested for weight, fineness and holding and resisting qualities. The specifications for concrete represent the application of scientific principles in the determination of dimensions of walls, beams, floors, etc. The complete set of specifications (in Spanish) will be loaned upon request at the Bureau or its district offices. Refer to file No. 1088.

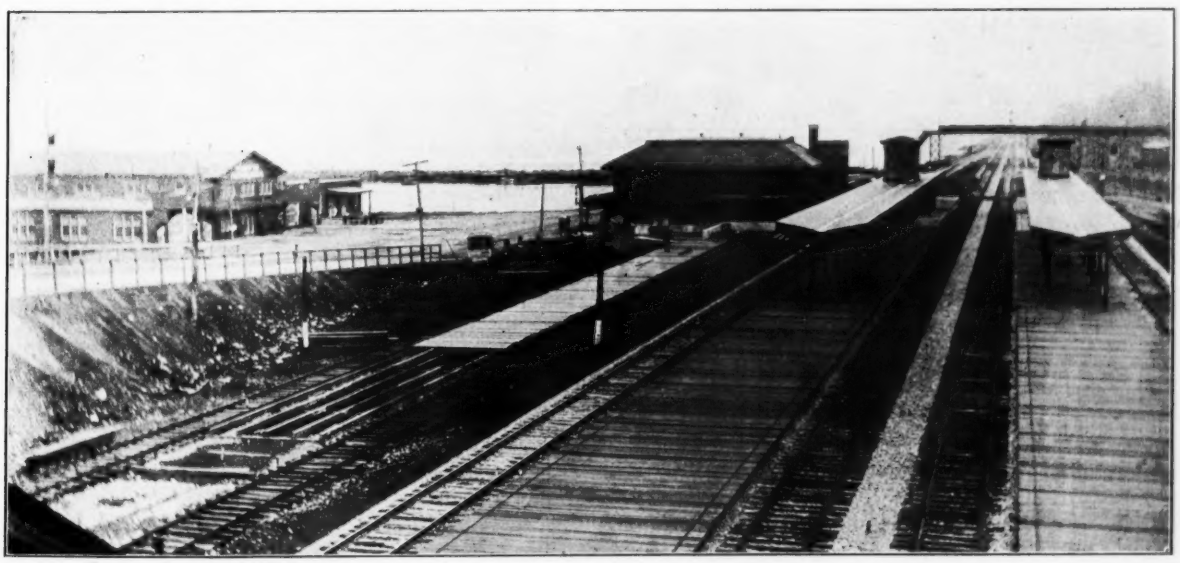
New Stations on the Lackawanna and New York Central

By REGINALD GORDON

Steel and Concrete Used Together with Brick in Station Construction. Facilities for Railroad and Conveniences for Public Important Factors

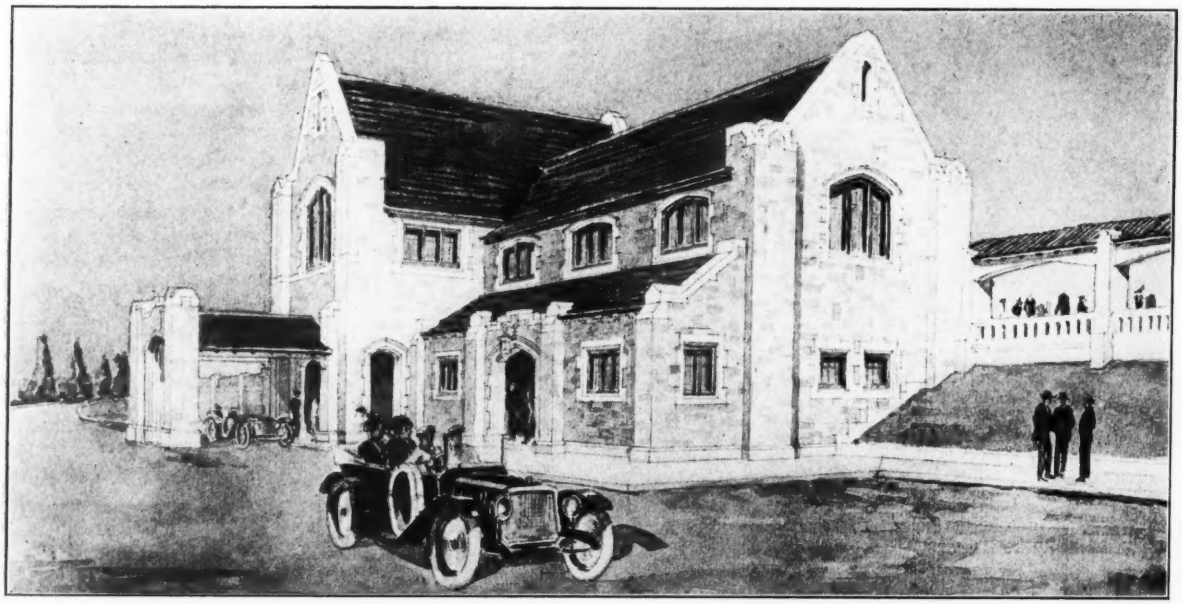
The Delaware, Lackawanna & Western Railroad completed a few months ago a station at South Orange, N. J., 15 miles, and has another under construction at Madison, N. J., 27 miles, from New York. Both of these stations comprise part of an improvement begun several years ago on the Morris and Essex division of this road, and at both places the grade of the tracks was raised in order to eliminate a number of street crossings. At South Orange the grade was raised 12 ft., the entire change in this respect being carried out over a distance of three-quarters of a mile, doing away with five important street crossings at grade. The design of the new station is in simple style combined with solidity. The tracks are carried over the street crossings on reinforced concrete arches. The building is constructed of dark tapestry brick with a roof of greenish tile. The railings and balustrades at the edges of the platforms are also of reinforced concrete of a simple yet pleasing design. One detail, small in itself, yet which adds greatly to the appearance of the finished station at all times of the day or night, is the design of the lighting fixtures that are placed on posts at intervals along the balustrade. Each standard is painted black and carries a glass lantern of soft amber color, thus avoiding any bright spots of light, and still being in harmony with the tawny caution light of the signal service. The fixtures are sufficiently numerous and so spaced that ample illumination and a good quality of light is secured. Although that part of the building fronting the street is 125 ft. long by only 23 ft. deep, it is continued transversely under the tracks 77 ft., thus providing large space for waiting rooms, ticket office, toilet rooms, telephone booths and express office, all on the street level floor. The platforms are extended to a considerable distance east and west of the shelters shown in the illustration, and have stairways leading directly into the station, as well as at the farther ends to the street.

At Madison, a station of unusual design is now under construction, Gothic in detail and of the later form of that style, is executed in granite of pinkish gray color. This improvement, in addition to the rise of grade for the purpose of elevating the tracks above the street level, has altered the position of the freight yard and entailed a change of grade as well as of location of the line for more than a mile. As this division of the Lackawanna is a very old one, built more than sixty years ago, the grades and curvature put severe limitations on the train loads. The design of this structure is entirely different from that of other new stations on the road, the modified Gothic being quite unusual for most railroad buildings. The roof of gray and dull red slate color makes a pleasing contrast with the stone of the main building as well as with the concrete of the posts and arches of the platform shelters. A large porte-cochere on the main facade of the building will afford convenient access in bad weather and also serve to neutralize the somewhat eccesiastical effect of the architectural treatment of the structure. Facing the main entrance a corridor leads directly to wide stairways which give access to both the east and west bound train platforms, the station being placed on the east bound track, since most of the traffic consists of commuters doing business in New York and Newark. The diagram of this building, which we show, illustrates the general arrangement of waiting, baggage and toilet rooms, etc. Another illustration shows the stage of construction in the early part of February of this year.



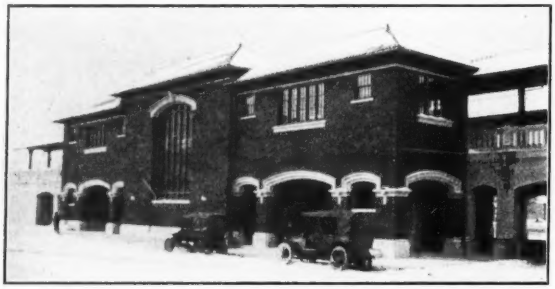
Beacon Station with Shelters on Island Platforms. New York Central Lines

In connection with the general improvement work and four-tracking begun on the Hudson division of the New York Central more than four years ago, the two stations, views of which are reproduced, have been recently completed. At Beacon, 58 miles from the Grand Central station, there stood an old station, built of wood, which had long since become obsolete. In



Architects' Drawing of Madison Station on the Delaware, Lackawanna & Western

planning a new station, a site for it was selected that would secure better alignment for the road. The former main tracks were on a short tangent at the station, and reverse curves both north and south of it made a re-

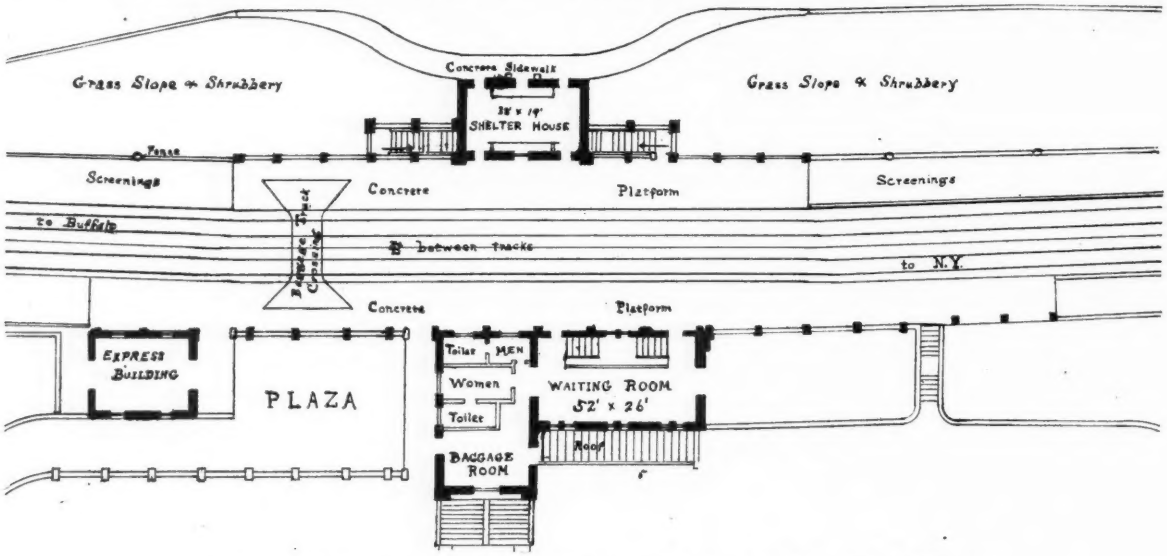


South Orange Station. D., L. & W.

location necessary. In laying out the plan for four tracks, the engineers, in order to do away with these curves, made a new location which involved filling in several hundred feet outside the old river bank for a

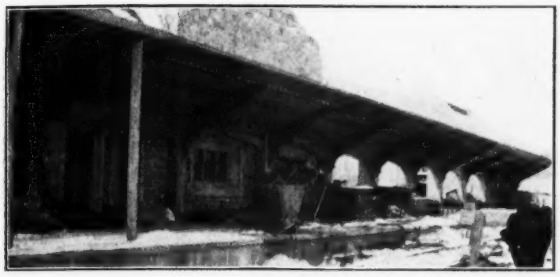
Rhinecliff Station. New York Central Lines

distance of three-quarters of a mile, also extending a large sewer and moving the ferry slip for the Newburgh-Beacon ferry out into the river more than 300 ft. farther, where a new waiting room and new slips were



Plan of General Arrangement, Madison Station. Delaware, Lackawanna & Western

constructed. The highway was raised to a new grade. This public road had a street railway track running down the steep hill from the town, east of the railroad right-of-way and crossing the railway by an overhead bridge, to reach the waiting rooms of the station and the ferry. The new station has been built on a site west of the right-of-way. Subways give access to the train platforms for passengers, and baggage elevators at con-



Shelter Brackets at Madison Station. D., L. & W.

venient points are provided. The main waiting room is 47 ft. 10 ins. square, of ample size for the community using it, totaling nearly 40,000 persons, as a large number of passengers to and from Newburgh pass through this station. The building is of granite on the lower courses, while dark tapestry brick is used for the main structure. The roof is of tile, harmonizing well with the surroundings.

At Rhinecliff, 88 miles from New York, in addition to the necessity of furnishing a more commodious and

Platform Shelter, South Orange. D., L. & W.

ornamental station, it was important to make a more convenient approach from the village street, and to do away with a dangerous crossing formerly necessary to reach the south bound track and Rondout ferry. The new station has been located north of the old, and the main waiting rooms, ticket offices, etc., on the east side of the right-of-way, and an overhead bridge and driveway for reaching the southbound track and water front, has been provided. The limitations of the site at this point made it necessary to make the stairways from the overhead bridge to the platform unusually steep.

The stations shown in other illustrations are only a few of the new structures that these two roads have built within the last few years. Thus the Lackawanna finished one at Mountain Station, one in Orange, N. J. (illustrated), as well as at Chatham, Convent, Morristown and Morris Plains; while the New York Central structures at Utica and Rochester, N. Y., have attracted the attention of many travelers.

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It is a world we need be careful how we libel, Heaven forgive us, for it is a world of sacred mysteries, and its Creator only knows what lies beneath the surface of His lightest image.—The Battle of Life.

Housing Competition and Public Exhibition

Announcement of Plans for Bringieg Together Best Thoughts on Subject of Housing Labor

Prizes aggregating $2,100 are offered for plans, sketches, grouping and arrangement, for the housing of immigrants in industrial towns. The competition is conducted under the auspices of the National Americanization Committee, with the co-operation of the various societies and institutes of architects and engineers. The contest closes May 1. The prizes are divided into two groups.

The first group covers plans for the housing of workmen in industrial communities not exceeding a population of 35,000. Entries in this class include plans for (1) single family houses; (2) combined family and lodging houses, which will permit separation of the family from the lodgers; and (3) boarding houses or community dwellings for numbers of single men or of single women. The first prize for this class is $1,000, the second $500, the third, fourth and fifth $100 each. In the first group the committee has in mind a new community produced by a new industry, with the consequent need of supplying dwellings for a large number of employes. A considerable proportion of these employes will be needed permanently; the rest, as the construction gangs, from two to five years only. In the statement of the conditions of the contest, which is being issued to competitors, it is pointed out that these two important considerations are the welfare of the tenant and the cost. The wages of the employes for whom the houses are designed are to be from $2 a day to $20 a week.

In the second group a first prize of $200 and a second of $100 is offered for a satisfactory substitute for the unused and side-tracked freight cars now used to house construction gangs on railways. In announcing the competition the committee calls attention to the fact that new communities clustered around new industries are being produced in this country with phenomenal rapidity. It is the small industrial town at present, not the large city, in which the "congestion" problem of the country is centered. Men flock by thousands to places where there are plenty of jobs—but no dwellings. In one New England town families are being "evicted," not because they cannot pay rent, but because they cannot get houses for the rent they can pay. A large percentage of these workmen are immigrants who have no way of creating American standards of living for themselves. If such standards are not provided for them, and insisted upon, groups of immigrant workmen are bound to follow various Southern European standards of living and customs, vitally affecting social health and prosperity. The community that results from these conditions cannot be truly American.

The aim of the contest is therefore to arouse interest in the subject, and to produce carefully worked out and entirely practicable housing plans and standards which it will be possible for employers and workmen and communities alike to demand and insist upon. In order that the result of the competition may be made immediately available, and may be drawn to the attention of those persons most interested or concerned, the competition will be followed by public exhibits not only of the results of the competition but also of any plans now in existence, or in process of execution, which architects, engineers, employers or corporations may care to submit. Inquiries concerning the competition may be addressed to the National Americanization Committee, 20 W. 34th St., New York.

Letters to the Editor

General Suggestions for Track Men

Editor Railway Engineering and Maintenance of Way.

Sir—First line your track, then surface it; then alternately line and surface it until it is true. In lining track, the outside rail of a curve ought to be selected as the "line" rail. On the tangent following this curve keep the same rail as the "line" rail. If the following curve is in the same direction as the previous one, the same rail should still continue to be the "line" rail. If the following curve is in the opposite direction to the previous one, continue the "line" rail for only about two rail lengths from the beginning of the curve; then transfer the lining to the outside rail of the curve and continue using this rail as the "line" rail until the curve is again reversed.

Follow closely the rules laid down by your company, as to allowance for expansion at the joints; noting this expansion under varying traffic, climate, temperature and other conditions, for the information of the engineer in charge.

After spiking the "line" rail, be careful to use the track gauge systematically between the heads of the rails, in spiking the "gauge" rail. Gauging between the bases of the rails in a track may produce unfortunate results, owing to varying heights of rails and widths of bases.

Unless you have standards laid out by your division engineer, widen the gauge on curves 1/16 of an inch for each degree of curvature by steps of ⅛ of an inch. The foreman should watch all gauging carefully; proper provision for varying widths of gauge being made in his track tools. The gauge would then be as follows:

From tangent to 2 degs., 4 ft. 8½ ins.
From 2 degs. to 4 degs., 4 ft. 8⅝ ins.
From 4 degs. to 6 degs., 4 ft. 8¾ ins.
From 6 degs. to 8 degs., 4 ft. 8⅞ ins.
From 8 degs. to 10 degs., 4 ft. 9 ins.

If you do not widen the gauge on curves the traffic will do so, by the grinding of the wheel flanges on the rail, to the detriment of both. To measure the degree of curvature, stretch 44 ft. of a tape line or cord, with three knots on it, 22 ft. apart, on the inside of the curved rail. The distance of the rail from the middle of the cord in half inches gives the degree of curvature.

If your company has no specific standard for super-elevation of outer rail on curves the following may be adopted as representing good practice: For track within the outer switch points in yards and terminals, no super-elevation; gauge widening is more important here. For road track on which speeds correspond to ordinary freight train running; ½ in. per deg. For high speed passenger track; 1 in. per deg.

In the matter of tie-plates, it may be said that the tendency is toward increasing their use. With treated ties the necessity becomes more apparent, as it is desirable to protect the wood in some way from the wear of the rail, because other things being equal, the treated tie has a longer prospective life than the untreated tie has. Tie-plates were originally made with the idea of being anchored to the tie. One of the first objections to the tie-plate was that if it became loose it not only did not protect the tie but actually facilitated the cutting and breaking of the fibers of the wood.

As a result of this idea, we have a great variety of tie-plate designs with spines, prongs, flanges or steps, which are intended to bed into the tie and make tie and tie-plate practically one piece upon which the rail may move, if any movement does take place, but which will not affect the intimate connection of tie-plate and tie.

On our leading roads some general instructions regarding the application of tie-plates have been issued for the guidance of trackmen.

One road recommends that tie-plates be used on all ties in high speed tracks on curves of two degs. radius, or over; on all ties in track subjected to heavy service; on all switch-ties, and ties on turntables, ash-pits, bridges and trestles; at water stations and at track-troughs, and through all road crossings and station platforms. Tie-plates should be used on all soft wood ties and on all ties that have been treated. Tie-plates should be applied according to standard plans and care taken that the shoulder will have full bearing against base of the rail.

Another road prescribes that in laying tie-plates before ties are placed in the track, the "line" side of the tie be marked and the plates put on, the other plate being then put on in its proper position by gauging it from the line plate. Tie-plates on new ties should be driven home with a proper appliance. If put on after rails are laid, the tie should be carefully adzed the full length of the plate, all spike holes plugged, the rail lifted, the plate slipped in and be settled into the tie with some proper appliance.

Sellew points out in his writing on the subject that the various designs of tie-plates on the market indicate a difference of opinion among engineers as to the form that is most effective. Besides the variation in the form of the plate there is some difference of opinion concerning dimensions for a given weight of rail.

The thickness of plates varies usually between ⅜ and ⅞ ins. and the width between 5 and 8 ins., the length between 8 and 11 ins. These dimensions include flat and flanged plates. Some plates are made the same thickness throughout, others are heavier at the shoulder than at the ends, but as a general thing it is evident that in many designs there is no need for a continuation of the same thickness throughout the length of the plate.

This brings us to a contemplation of European practice which is to incline the rail. Some of our leading roads are experimenting with a tie-plate so made as to tilt the head of the rail inward in order to approximate to the coning of the standard wheel tread. One evidence of the sentiment favorable to these experiments is the practice, prevalent to some extent, of inclining the rails on curves where the wear on the rails has been found to be very heavy.

There have been two ways of securing the inclination desired by some engineers. Ties may be adzed, but this method is open to the objection that the mechanical wear of the base of the rail or the tie-plate on the tie soon alters the angle of inclination. The other method involves the use of a special tie-plate, which will give the desired inclination without adzing the tie at an angle, and without the tendency to wear down the tie, which results from adzing at an angle. Where such work is being carried out on American railroads some few general instructions on the subject may be found to be of service.

In passing from the upright to the inclined rail, or

vice versa, the transition can be made within the elastic limit of the rail, in about a quarter of a rail length, by lightly adzing about four ties and dapping in the plates. In replacing flat tie-plates by inclined plates under intermittent traffic, the following method of operation should appeal to the track man.

Have a supply of wedge shims ready for temporary adjustment of the track. Pull the spikes on such a stretch of track as can rapidly be made safe without delaying train movement. Remove all obstructions on this stretch of track. Clean the tie under the rail, by slight adzing or otherwise. Fill all spike holes with soft wood plugs, not too tight fitting. Slip in the special plates from the outside of the rail. Spike the "line" rail on the inside first; bringing the shoulder of the plate against the base of the rail. Using the track gauge carefully, tap the shoulder of the plate under the gauge rail against the outside of the base of the rail; then spike the inside first. Hold passable flat plates for use in replacement of incidental worn flat plates elsewhere, if they seem desirable. Tap your spikes down from time to time, as the plates seat themselves under traffic.

TRACKMAN.

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How to Maintain Track

Editor, Railway Engineering and Maintenance of Way:

Sir—Railway track is designed and built for the purpose of carrying the traveling public and freight over it in the form of moving trains. A railway track receives its attention, according to the allowance made for its maintenance. There is, therefore, opportunity for the display of executive, of skill and judgment in distributing work to advantage for a railway company. Owing to the fact that the poorer the track in relation to the traffic, the greater the expense for maintenance and renewals, more money has to be spent.

The writer has seen on quite a number of sections where he has been employed as section foreman, and especially when assistant foreman in construction gangs, that in hundreds of cases money has been spent over and over again by some section foreman on the same stretch of track and no improvement could be seen after the work had been done; it amounted to merely patchwork.

Good track, in normal conditions, requires skill, judgment and executive ability. There is a growing recognition of the fact that no foreman can maintain track up to normal, unless the following things are to be had: First, good gangs. Second, good surface. Third, good alignment. If one of the three items is absent, trouble begins.

A method of keeping good track remains a secret to many track foremen. A foreman in charge of work is merely an instrument, if he fail to use his full powers rightly, if he has all the good intentions of the world, he is liable to fall short in the discharge of his duty. We have all reached the conclusion that success of a mechanic rests upon his judgment, therefore, he should be educated. How can anyone become a successful mechanic without it? It has been proved that the promotion anyone receives rests in large measure on his education.

We must admit that a good many of our railways have favored a more enlightened policy. It is the necessity for the general improvement of a section foreman so that he may be able to maintain the track in proper relation to the increasing traffic which heavy loads impose upon it. Financial conditions often compel railways to conduct their maintenance with very limited means, yet the track must be made to carry the traffic, and this being so, the track foreman must make every minute count.

Allow me space to mention that nothing looks any better than a neat line. When I was employed as assistant foreman in construction gangs I always figured true alignment of track to be an important economy of maintenance, for the easy and safe running of trains. Too much time and labor cannot be spent for true alignment. Money spent for true alignment is well spent and will be repaid many times over in lessened repairs. I have realized on some sections a thorough and complete realignment was necessary. I have never seen a successful track liner unless he was 400 to 450 ft. behind his lineman. Anyone doing track work will agree that the opportunity to learn the true worth of the business only comes to a man who has worked in a construction gang.

I would be glad to see letters appear in print from other brother track foremen. I think Railway Engineering and Maintenance of Way will be of permanent service to railways and to their employes.

HENRY KOCH,
Foreman, Sec. 31, E. P. & S. W.
Las Tanas, N. M.

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Operation of Section Motor Cars

Editor, Railway Engineering and Maintenance of Way:

Sir:—In regard to this subject I would like to say that I have made a careful study of this part of our maintenance of way. For the benefit of those who have not had the experience with section motor cars, I would like to say that we have used motor cars on thirty sections of our road for the past five years with the best results. We are using the No. 26 and No. 32 styles of the Fairbanks-Morse cars. These cars are better adapted to our work on account of their speed and weight. Our sections are 12 miles long and we have one foreman and six laborers to each section.

Recently the price of gasoline advanced to the point to where it was almost prohibitive; in fact, it increased the cost of motor car operation to the point where it was almost necessary to go back to the lever car. To meet this emergency it was necessary to reduce the cost in a very short time and to reduce the cost to as low a point as possible.

After experimenting for 10 days with different mixtures of gasoline oil and kerosene, I found that we got the best results from a mixture of half gasoline, half kerosene with one-quarter pint gas engine oil to each gallon of the above mixture. I made the test on three sections where foremen had taken an interest in this and where the conditions were not so favorable as on other sections. I have a heavy inspection car of the 32 type of Fairbanks-Morse cars, and I also made several tests on this car. The results with the new mixture proved even more satisfactory than the old mixtures of gasoline and oil. Instructions have been issued from the general manager's office to all foremen to put this new mixture in practice and with instructions as to manner of handling to avoid waste.

I would like to state further that we had up to the time we commenced to use the new mixture all kinds of engine and spark plug trouble. Piston rings would become imbedded in carbon, which caused a great loss of power as well as heat in the engines. This took place to such an extent that cars would not pull over the heaviest grade until the engines were cooled down.

Spark plugs were always giving trouble on account of getting so dirty that they would become short circuited.

All this trouble has stopped and every day I hear section foremen say that they are getting to and from their work without any trouble whatever, as the new mixture affords better lubrication. No change of adjustment of carburetor is necessary, as it only takes the usual amount of fuels, but in some cases less, where a change of adjustment has been made, it has invariably been to increase the air and reduce the gas.

If this appeals to those who use the motor cars for section use, I will be glad to give them a comparative report showing the exact saving, which is in excess of 40 per cent.

L. W. TURNER,
Roadmaster, G. & F. Ry.

Vidalia, Ga.

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Dynamo-Electric Machinery for Railroads

By REGINALD GORDON

Generating and Transforming Units Described and their Operation Explained

The art of designing electric generating machinery has advanced so rapidly and so far that units of 30,000 kilowatts, equivalent to 40,000 horse power, are becoming common in railway generating stations. The term "generating unit" is applied to any combination of steam engine, or steam turbine, or water wheel that drives a dynamo; prime mover and generator commonly being set on the same base, or foundation. Generators in railway power houses are usually built to furnish alternating current, abbreviated to the letters A. C. Sometimes direct current, abbreviated, D. C., machines are used, but chiefly for shop motors and lights, or for street and interurban railways where the energy is not transmitted more than a few miles. In railway sub-stations, a type of machine called a rotary converter is installed, which runs as a motor driven by A. C. power, and at the same time generates D. C. power which is fed into the third rail or trolley wire.

Generally speaking, generators may be classed either as self-excited or separately-excited. The diagrams used here show this distinction for machines having only two poles in the field, but the principle can be extended to include any number of poles. Alternating current generators supplying power to railways are almost always separately excited. The exciting generator or "exciter" as it is called, is sometimes belt-driven from a pulley on the shaft of the main generator, or mounted directly on that shaft. Its output is D. C. energy that goes through the coils of the field magnets of the large machine, and is regulated in amount according to the demand for power from the latter. All D. C. generators must have a commutator, or device for collecting all the positive currents in the armature circuits, and connecting them with the positive terminal; and collecting all the negative currents, and connecting them with the negative terminal of the machine, whence they are distributed by the leads or bus-bars to the switchboard. This commutator is made up of a large number of segments or narrow pieces of copper, each insulated from those next it by narrow strips of mica, bakelite or other approved insulation. This fact limits the voltage or electro-motive force that can be generated in one D. C. dynamo; so, when power must be transmitted at high voltages, it is almost always done with alternating, and not with direct current. If D. C. power must be obtained for lomotives or for shop motors from a distant power plant, the A. C. current must be transformed to D. C., at points where it is to be used or locally distributed.

For electric locomotives or motor cars either direct or alternating curent may be used. It has never yet been definitely settled by electrical engineers which is the better system for railway work under all conditions of distance, grades, speed, train load, density of traffic, etc. The two systems are being used about equally. The Pennsylvania Railroad has both, employing 600 volt D. C. locomotives for its New York terminal electric service, and 11,000-volt A. C. for the motor coaches used on the Philadelphia-Paoli electrification described in the January, 1916, issue of Railway Engineering and Maintenance of Way. Both systems are alike in one respect. They both generate alternating current energy in the power houses and transmit it at high tension to various points on the electrified division. On the roads using D. C. this alternating current must be transformed to direct, and thence transmitted to the third rail or overhead conductor. On the other hand, roads equipped for A. C. operation with the energy transmitted from the power station may be fed directly into the conductor from which locomotives and cars draw their supply.

Where power must be transmitted long distances, A. C. energy must be supplied, not only because the amount of power that can be distributed through a wire circuit increases almost in proportion to the rise in voltage at the source, but also because, as before mentioned, it is not practicable to build D. C. generators so well insulated as to stand the strain of high tension between adjoining commutator bars and armature circuits. For these reasons the common practice is to install steam turbine-driven A. C. generators, transmit the 13,200-volt A. C. energy to sub-stations located 12 to 20 miles apart along the road, and at each sub-station convert A. C. power into low tension D. C. power at 650 volts.

Where A. C. energy is to be transmitted at a voltage higher than that for which it is practicable to design a generator, the output of the latter is raised by a transformer to the desired value, and lowered at the sub-station in a similar manner.

A transformer (called also a static transformer, because it is stationary and does not move, nor has it

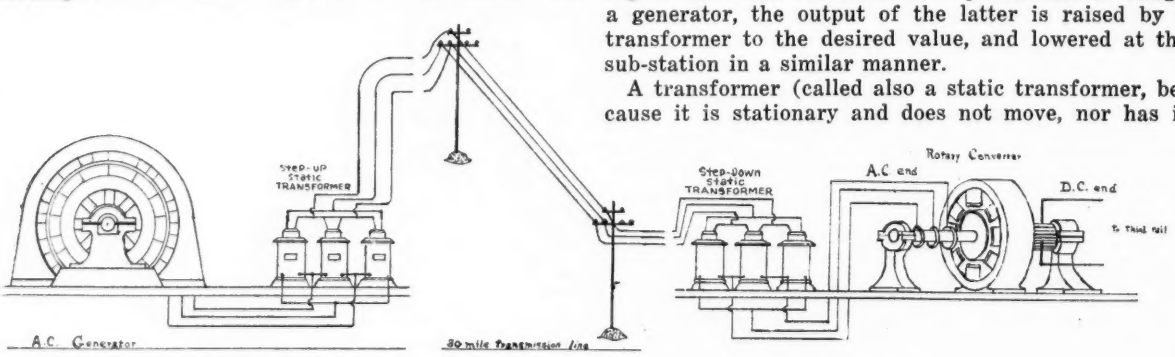
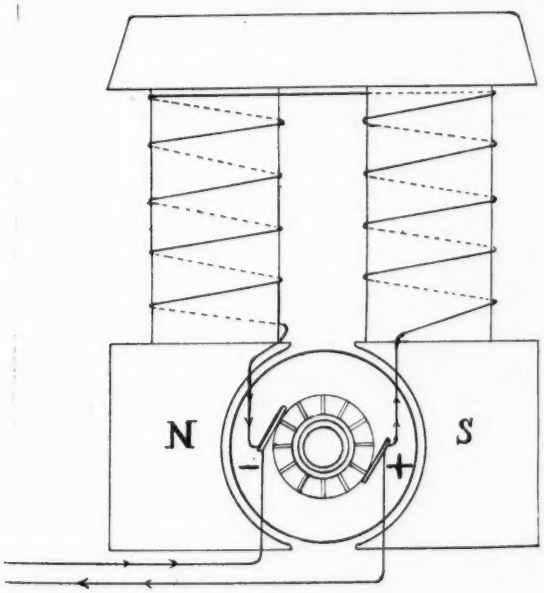


Diagram of Typical Power House, Transmission Line, and Sub-station

any moving parts) is an electro-magnetic device for alternating current, consisting of an iron core, or frame, on which is wound two circuits. One of these consists of a few turns of thick wire, and the other of a large number of turns of fine wire wound close together, but insulated from each other; the thick wire being connected to the generator and the fine wire to the line. Every alternation of current through the winding connected to the generator induces a current in that connected to the line; but the voltage in the line coil, or secondary, is higher than that in the primary, in proportion as the number of turns of the fine wire is greater than that of the thick wire.

Thus a dynamo giving alternating current at 13,200 volts is conected to a transformer that "steps up" the voltage to 44,000 volts, at which pressure it is transmitted along the railroad to a sub-station where another transformer is situated, by which the pressure is "stepped down" to 11,000 volts. At this voltage it is fed into the overhead conductor for use with A. C. locomotives and motor cars. If these, on the other hand, are designed for D. C. power, the transformer at the receiving station must be supplemented by a rotary converter, referred to in the first part of this article. Rotary converters usually have an armature, or rotor, having two entirely separate systems of circuits, one of which connects with collector rings on the A. C. side and the other with a commutator and brushes, from which direct current power is taken off for the third rail or overhead wire.

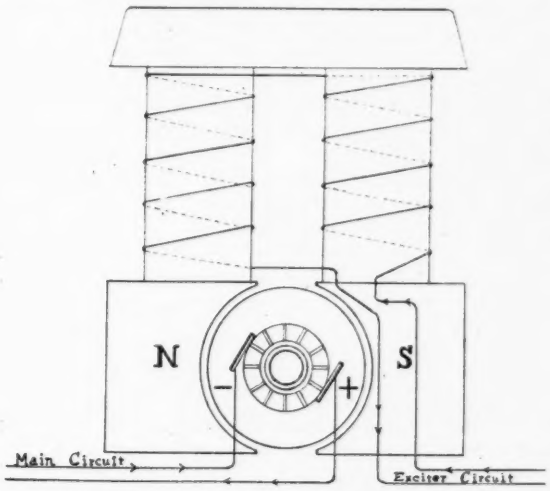
According to local governing conditions, some roads use one system and some the other. Thus the New



Self-Excited Direct Current Generator

York Central and Pennsylvania distribute A. C. energy from the power stations at 13,200 volts and convert it at sub-stations to 650 volts D. C. The New Haven distributes A. C. at 22,000 volts, and by the use of special transformers supplies it at 11,000 volts to the locomotives.

The Chicago, Milwaukee & St. Paul receives A. C. energy at 100,000 volts at the sub-stations, which then distributes it as D. C. current at 3,000 volts to the overhead wire. It must be remembered that in every transformer of energy, say from 13,000 volts to 44,000, or from 2,200 to 110, no energy is created or brought into being. It is simply changed in voltage, or transformed from one voltage to another, but the energy before or after the change remains the same. A current of 200 amperes at 13,000 volts, if transformed up to 52,000 volts, is correspondingly diminished in quantity to 50



Separately-Excited Direct Current Generator

amperes, or less. This latter quantity, however, can be distributed by a smaller wire than the former in the ratio of 1 to 4. This smaller wire is the secret of success of high-tension A. C. transmission.

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Railways in Colombia, South America

Following the article in our February issue by Mr. Rosales on the Colombian railways, it may be of interest to observe that consul Isaac A. Manning at Barranquilla has recently reported to the Department of Commerce at Washington what the Colombian government is doing in regard to the construction of the railway from Cucuta to the Magdalena river. An amendment to the law of 1912 which provided for the building of this line stipulates that the government shall now contract therefor; receiving bids for the work within 120 days of publication of the call in Colombia and abroad. The invitation for such bids shall include the specifications and conditions of construction in accord with the surveys made by the commission established for the purpose. The Colombian government has been authorized to secure a loan for the needed funds. As soon as the loan has been arranged the contract will be awarded and the necessary bonds will be issued. This will doubtless be of moment to such of our own countrymen as are interested either in railroad supplies or in the construction of railroads.

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In Belgium there are 48 miles of railroad for every 100 square miles of land. Railroad mileage is densest in that country, Saxony coming next with 34 miles to every 100 miles of land. All Germany has but 19 miles, so calculated, while Great Britain barely exceeds that, having 19 3/10 miles. The United States, as a whole, can boast of but 7 miles to every 100 square miles of land; but New Jersey has 30¾ miles; Massachusetts more than 25 miles; Pennsylvania about 25¾ miles; Ohio 22½ miles and Illinois about 21½ miles. Taking the United States as a whole, considering the population, we have 26 miles of railroad for every 10,000 inhabitants and Europe, as a whole, has but 5 miles for every 10,000 inhabitants.

Highway Crossing Elimination on the D. & H. and the C. & A.

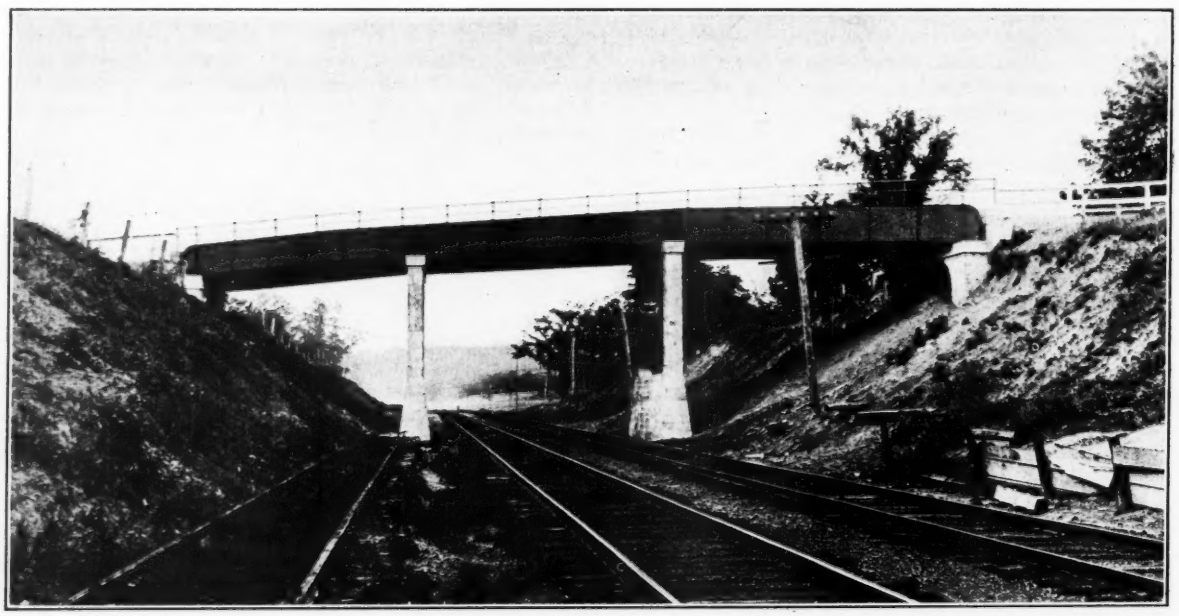
Examples of Structures used for Raising and Depressing Tracks in Efforts to Prevent Crossing Accidents

Some one has well said that it is harder to change human nature than it is to abolish grade crossings, and this statement was based on results obtained by one of the large railway systems of the country, after a thorough investigation by its representatives of what the people are in the habit of doing when they come to a railway crossing at grade. The actions of more than 17,000 drivers of motor vehicles were observed, practically 12,000 of whom, or more than 69 per cent, looked neither to the right nor left before crossing the rails. Less than 3 per cent of the whole number looked one way only, and about 28 per cent looked both ways; 3,300, or about 19 per cent, crossed at a reckless speed, and only 35 of the total number came to a full stop before going on. More than 4,800 drivers of horses were included in the investigation, and 39 per cent of them looked in neither direction on approaching the crossings, while 8 per cent looked one way only and 52 per cent looked both ways. We can readily see, then, that carelessness of the public is the underlying cause of accidents at the standard menace known as the grade crossing. The good work of elimination and furnishing other means of protection is still meeting with careful consideration.

The Delaware & Hudson Company has on its system 566 crossings which are unprotected at present, and 290 protected. Of the protected crossings, 37 are treated by the elevation of tracks, 78 by depression, 107 by gates, 93 by flagmen, and 90 by signals or crossing bells. In the past five years six grade crossings have been eliminated, which is most creditable. One of these six was an overhead crossing installed at a cost of $15,238.06, the Delaware & Hudson assuming $7,851.22 of this amount and the balance being divided between various individuals and companies. The other five were of under-grade construction, costing on the average $57,283.54, which was divided as follows: Delaware & Hudson, $27,108.29; individuals and other companies, $30,175.25. The average cost for installing crossing gates has been $700.00; the expense of flagmen has averaged $600.00 each per annum, and the cost for installing signal bells and other devices has averaged $500.00 each.

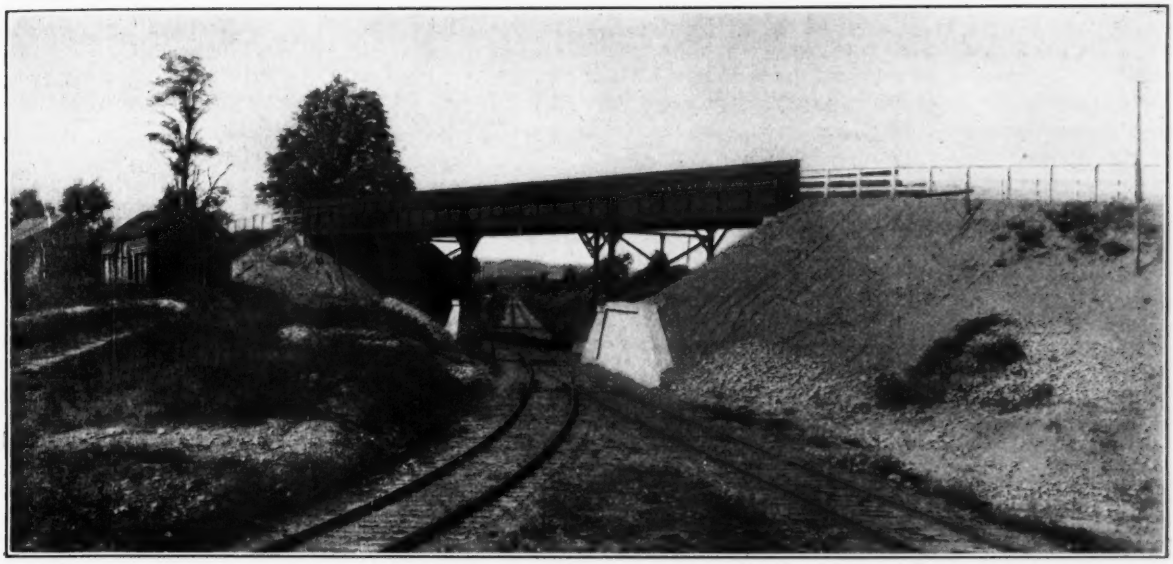
Personal injury claims paid on account of grade crossing accidents have amounted in each of the past five years to:

1911	$34,749.00
1912	20,394.32
1913	55,787.95
1914	12,259.92
1915	21,610.85
The total amounting to	$144,802.04

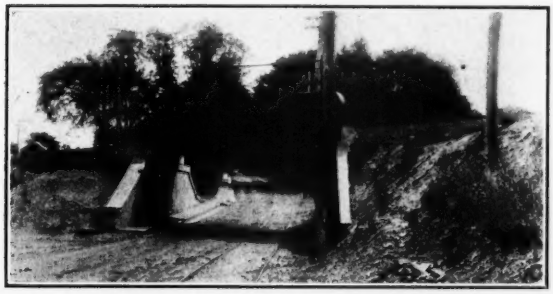


Highway Overcrossing D. & H. near Bainbridge, N. Y.

In the state of New York the law governing the elimination of grade crossings requires the railway to meet 50 per cent of the total expense, while the state and the municipality interested share equally in the balance. It would seem from a careful consideration of the whole matter that an equitable adjustment of such expenditures would result should the total amount be equally divided among all parties in interest. The situation as to crossings varies on the different railways, depending upon circumstances—such as the density of population, frequency of traffic, and the public demands. On the Detroit, Toledo & Ironton, a representative line of the class where circumstances are not what might be called insistent, there are no grade crossings in process of elimination at present, nor have any such crossings been eliminated in the past five years. This line today is burdened with 259 crossings at grade, of which 19 are protected and 240 unprotected. Gates are in service at



Overhead Crossing, D. & H., at Greenwich Junction, N. Y.

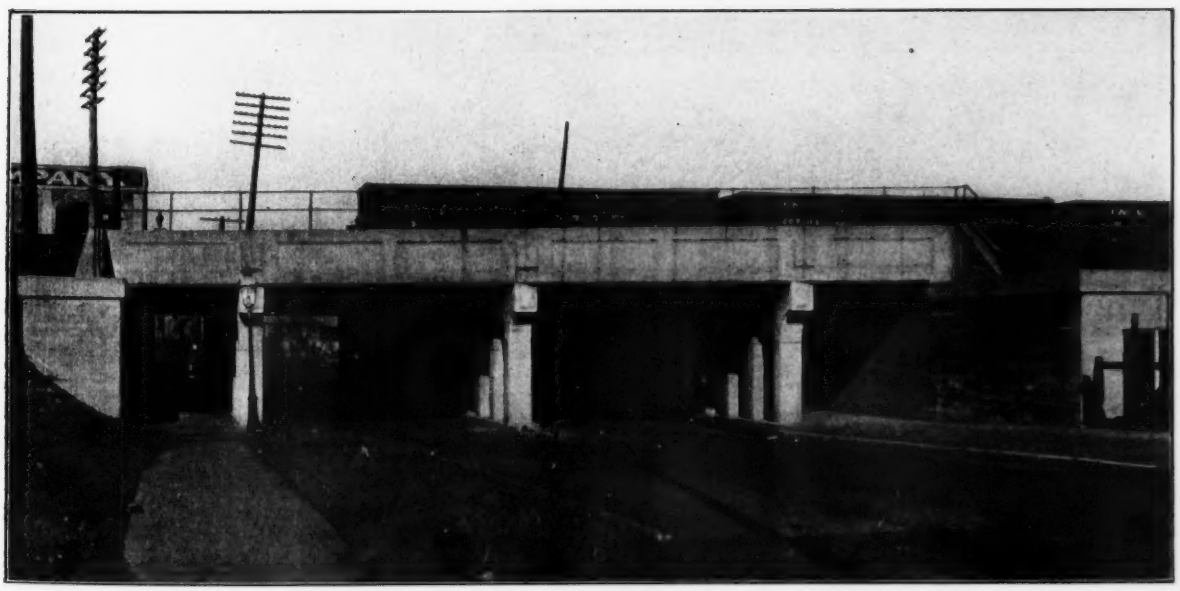


Inner Grade Crossing, D. & H.

7 of the so-called protected crossings. At 9 of them flagmen are in regular service, and 3 are provided with suitable alarm bells.

The cost for installing gate protection has averaged $475, to which is added a 10 per cent depreciation charge per annum. Gatemen and flagmen receive each $30 per month, and the average cost for installing alarm bells has been $300. As there have been no expenditures to separate the rails and the highway, the Detroit, Toledo & Ironton has had no occasion to come within the law which provides for a 50 per cent charge against the

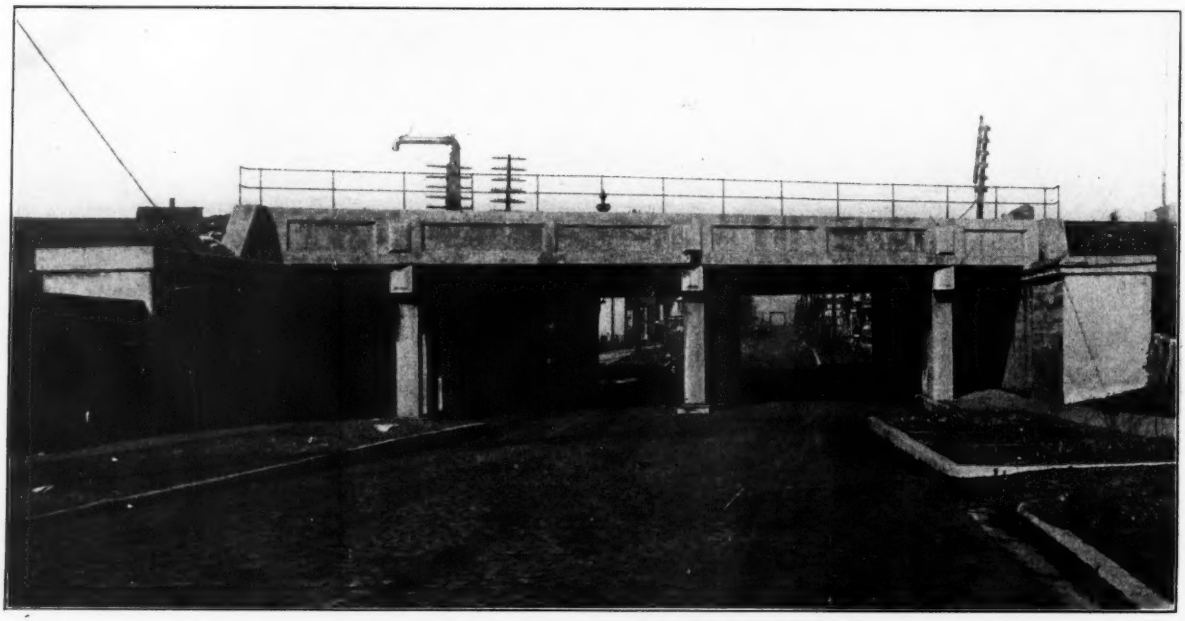
Overcrossing, D. & H., at Rupert, Vt.



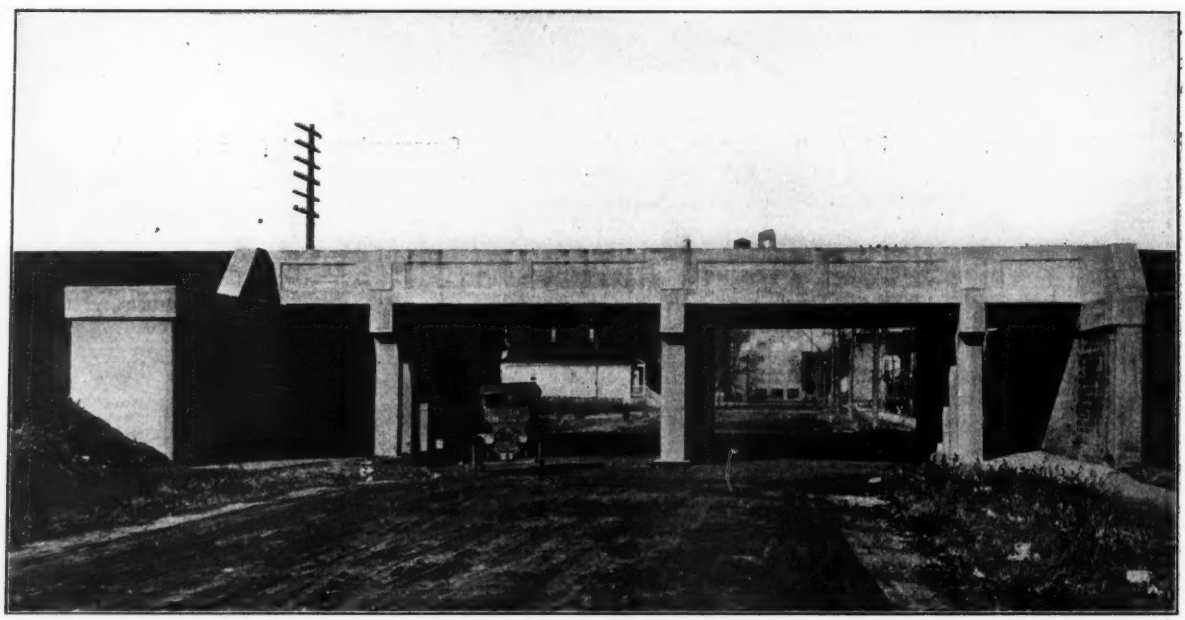
California Avenue Overhead on the Chicago & Alton in Chicago

carrier, the balance to be adjusted equally between the state and the municipality interested.

Shifting the scene of operations from the Central West, there is one of the large Eastern systems, of more than 2,000 miles, which has to contend with a total of 1,947 highway crossings, 813 of which are protected and 1,134 not protected. In addition, there are 450 overhead structures and 332 cases treated by a depression of tracks. Elimination is still in vogue, and much work in this direction is being accomplished. Of the protected crossings at grade, 355 are provided with gates and 293 are made as safe as circumstances will permit by flagmen, while 165 are furnished with bells or so-called automatic flagmen and bells. In the matter of eliminating grade crossings the average cost the past five years has been $28,000, not including a heavy expenditure of more than $1,500,000 in one of the busy, thriving towns on the line. As there is no definite data covering the work of depressing tracks the figures given represent the cost of elevation only. To erect gates has, on the average, cost $800 and to man them $740 each annually. At crossings protected by flagmen only the annual expense is also $740 each. Crossing bells come in at $545 for the installation with an annual maintenance charge of $100 for each bell. The average cost of installing automatic flagmen is $600 each, with a maintenance charge of $100 annually.



Albany Avenue Crossing on the Chicago & Alton, Chicago



An Excellent Example of an Overhead Crossing on the Chicago & Alton, at Chicago

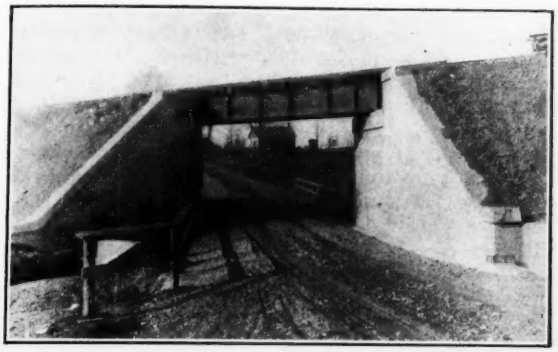
In the past five years seven grade crossings have been eliminated each year on the average.

The amounts paid for personal injuries at highway

crossings in the five calendar years ending with 1914 are as follows:

1910	$41,995.17
1911	69,859.33
1912	27,394.04
1913	54,970.29
1914	89,964.76

Even with more protection it would seem that the personal injury question is not an easy one to solve, presumably because at crossings which are protected either by gates or flagmen automobile drivers, particularly, exercise no care as a rule, and as the use of these machines becomes more common the danger of accidents increases. Until grade crossings are still further eliminated it will not be possible to secure data which will be reliable for comparisons between the cost of installing absolute protection and the saving thereby and the results arising from grade crossings, protected by gates or otherwise. The three examples of superb reinforced concrete construction on the Chicago and Alton which appear in this article show what substantial protection is afforded in the city of Chicago.



Under Crossing, Castleton, Vt. D. & H.

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Mechanical Elimination of Seams in Steel Rails

Increased weight of rolling stock and speed of traffic have led to increase in size of rail sections, requiring changes in the methods of rail manufacture. It is not surprising that new and unexpected physical weaknesses should develop in the heavier rails. One of the chief troubles has been failures through crescent-shaped pieces breaking out of the rail flanges, followed by at least one, and in many cases several, ruptures across the whole section of the rail. This statement was made by Mr. Robert W. Hunt a short time ago when speaking to the members of the A. S. M. E. Investigation shows that in practically each case of rail failure there was a more or less pronounced seam running longitudinally in the bottom of the rail near its center. This seam was at the top of the curve of the crescent-shaped break and is undoubtedly the point at which the fracture starts.

As a result of an investigation, Mr. T. H. Mathias, assistant general superintendent of the Lackawanna Steel Co., determined that the most certain way of getting rid of seams was to remove that portion of the metal which contained them. He believed the primary causes of seams existed in the ingots and were caused in the casting of the ingots. The surfaces of ingots display disk-like apertures, due to entrapped air, which in rolling can easily become elongated into a dangerous seam. It was clear that the surfaces of the ingots are decarburized to the extent of eight to ten points carbon and to a depth of 5/16 in.

The removal of the surface metal is effected by a hot sawing, or milling operation during the process of rolling. The ingot is reduced to a point where the product is 75 per cent finished, in the form of a partially shaped bar 60 ft. long, when it is entered between two pinch rolls with the flange side up and forced between two milling saws. A second set of rolls pulls on the bar and aids in holding it in line for the milling operation. The milling saws are 5 ft. in diameter with an 8-in. face and revolve at a peripheral speed of 2,500 ft. per min. Metal is removed from the top and bottom of the bar the main object being to eliminate the seams from the central portion of the bottom of the rail which has been the starting point of the moon-shaped cracks, and from the top or bearing surface of the head of the rail.

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Food for Careful Consideration

The supervisor of station service of the Baltimore & Ohio has recently made some startling estimates which are well worthy of more than ordinary attention. He has put into pamphlet form, for general distribution, data on the possibilities for economy in railroad service covering office administration, heating and lighting, car cleaning, maintenance, use of fuel, ice, brooms, mops, in fact every phase of effort connected with the science of transportation.

In discussing the use of material, supplies and facilities generally he goes on to say:

"If one incandescent electric light were left burning an hour unnecessarily at each of the 2,500 agencies on the Baltimore & Ohio, the loss of electric current would amount to 125,000 watts, or sufficient electricity to supply the average home with illumination for 18 months." He also points out that the economies within the possibility of the employes of an average railroad system, if rigidly adhered to during a year would result in a saving equal to the purchase price of 1,548 homes, 8,601 steel gondola cars or 225 passenger locomotives of largest design.

This is food for consideration by railroad employes as well as general officers who have the interests of the great railroad companies which they serve at heart. The pamphlet should have a wide circulation and thereby produce wonderful results.

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International Engineering Congress, 1915

The Committee of Management, International Engineering Congress, 1915, announces that the volume on mechanical engineering is ready for distribution and the members who have subscribed for this volume will soon receive it. The other volumes will be issued as rapidly as possible. Owing to the large amount of material to be reprinted and the thousands of copies to be bound, the work cannot be carried on with greater speed. However, it is hoped that within two months the entire set will be completed.

Members who did not send in their final selections may be disappointed in not securing all the volumes they might have had in mind, and at this date the committee has decided to close the lists for certain volumes which have been sent to the press. It may be possible to supply members who would apply at this late hour with copies of volumes which have not gone to press. This notice is signed by W. A. Cattell, secretary, 425 Foxcroft building, San Francisco, Cal.

The Principles of Railway Signaling

Description of the Elements of Automatic Block Signal System, Showing Types of Semaphore Signals Used

The purpose of Mr. Harold McCreedy in addressing the Richmond Railroad Club was not to discuss the technical details of signaling, as that subject would occupy very many books. It was his intention, he said, to deal with general principles, and to describe, briefly, appliances which are standard in America.

The slogan in the signal world, as in other branches of railroad work, is, "Safety First." Signals would not be useful if their indications could not be relied on. In the designing of signal apparatus, the element of safety is the primary one which the designer takes into consideration and keeps as a guide all the time. If any part of the apparatus fails or if any part of it breaks, provision is made so that the signal arm assumes the stop position automatically. All the electric circuits

Example of Automatic Block Signals on the Southern Pacific

are designed so as to fail on the side of safety. This may cause delay, but not disaster.

Signaling may be divided into two great branches. The first is the interlocking branch, which deals with the control of train movements at terminals and crossings. The second branch concerns block signaling. The American Railway Association has some definitions for block signal work which are of interest and are here stated.

"A block is a length of track of defined limits, the use of which by trains is controlled by fixed signals.

"A block signal is a fixed signal controlling the use of a block. The word 'fixed' refers to location only."

Block signals may be classified in three ways: 1st. As to manner in which their day indications are displayed. 2nd. As to the manner in which they are controlled and operated. 3rd. As to what they control. Under the first classification there are: (a) Banner signals, the indications being displayed by a revolving banner. (b) Disc signals, the indications being displayed by a movable disc in front of a fixed background. (c) Semaphore signals, the indications being displayed by the position of an arm moving in a plane at right angles to the track. In all types under class No. 1 the night indications are given by colored lights.

Under the second classification there are: (a) Manual, the signal being controlled and operated by man power. (b) Controlled manual, the signal being operated manually and constructed so as to require the cooperation of the signalman at both ends of the block. (c) Automatic, the signal being operated by power which is controlled entirely by the presence or absence of a train in the block, or the conditions of the track.

Under the third classification there are: (a) Home block signal, a fixed signal at the entrance of a block to control trains in entering and using the block. The indications displayed by a home signal are "stop" and "proceed," or in some cases "stop," "caution" and "proceed." (b) Distant block signal, a fixed signal used in connection with a home block signal to regulate the approach thereto. An absolute block system is one which never allows more than one train in the same block at the same time. A permissive block system is one which may allow more than one train in the same block at the same time, provided the trains are moving in the same direction and the second train has been warned by signal that another train is in the block.

In the home and distant block system, the home signal, situated at the entrance of the block, controls trains entering the block; the home block signal is placed at the top of the signal mast. This home semaphore is a two-position signal, one in which the signal blade has but two positions.

In the last two years, however, the three-position signal has come into general use. Normally, with a train in the block directly ahead, the semaphore arm stands out horizontally; with the block directly ahead clear but the second block ahead occupied, the arm occupies the 45 deg. position up in the air; with two blocks directly ahead unoccupied, the signal occupies the straight upward or vertical position.

A clear home signal as used in the home and distant system, indicates that the block directly ahead is clear or unoccupied. However, the use of a home signal alone would not be sufficient for the rapid operation of trains, for the enginemen would always have to be prepared to stop right at the signal if there were a train in the block ahead. A second signal is provided; the distant signal, at the entrance of the first block back, to give the enginemen an indication as to the condition of the home signal next ahead so that he can be ready to stop, if necessary, when he gets to that home signal; and in the meantime, he can keep on going.

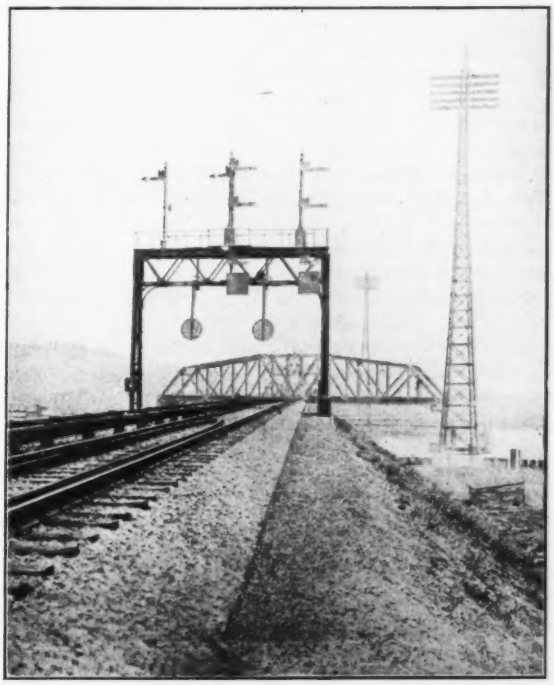
In the three-position system, there is but one arm on each signal mast. The arm is always in one of three positions. At horizontal it indicates that the block directly ahead is occupied; when the signal arm is in the 45-deg. position, it means that the first block ahead is clear but the second block ahead is occupied, and that, therefore, the enginemen must proceed under control so as to be able to stop at the next signal ahead. When the arm is straight up, parallel with the mast, or in other words, when it is vertical, it indicates that two blocks ahead are clear. During the last two or three years, the Pennsylvania Railroad has adopted a system for giving the enginemen information with regard to three blocks ahead. This involves a signal with two arms. The upper arm operates in three positions and the lower arm operates in two positions.

Speaking generally the block system is a system whose primary object is the facilitation of train move-

ments, to enable one to put on a given stretch of track the maximum number of trains and keep the trains moving, and still prevent them from getting too close to each other. The block idea involves the division of the track into sections of a certain length. If the traffic is very dense, it is necessary to make the blocks very short so that the trains can be brought closer together. On the other hand, if the traffic is not so dense as to require very close spacing of trains, the blocks may be made longer. On the Southern Pacific some blocks are two miles long, that is over ten thousand feet. On certain interurban electric roads there are blocks five miles long. On the other hand, there are blocks 600 ft. long. In the New York Subway, for example, the average length of block is 800 ft., the trains running with a minute and a half headway; this is as close as the trains can be spaced with the present braking equipment. The length of blocks is, therefore, governed solely by the number of trains to be run in a given time.

Example of Three-Position Signal on One Mast

There are two kinds of block signaling. The first is the manual system, where, at block towers placed at intervals along the line, the signals, which are of the mechanical type, are moved by hand by the towerman. This man receives word by telegraph or telephone from the towerman in the block stations on either side of him, so that before a train passes a tower the towerman communicates with the man ahead in the next tower, to see whether the block between them is clear. If the block is clear, the train enters, the towerman places his signal to danger and thus the train is protected. That



Example of Signals Protecting the Hackensack Bridge

is why the manual system is sometimes called the telegraph block. There is also the controlled manual system, employing what is known as the track circuit. In this scheme, whenever a train enters the block, it throws the signal automatically to stop; moreover, the towerman cannot pull his signal to the proceed position, unless the block is actually unoccupied.

The most important branch in this field, however, is that of automatic block signaling, where the signals are absolutely independent of manual control and are power operated, generally by electric motors. This motor may be operated from a set of batteries, or it may be fed from an alternating current power transmission line strung along the right-of-way. The power for running the motor is carried over the contacts of a relay, which contacts are not closed to permit power to pass to clear the signal until the block directly ahead is unoccupied. When a train enters the block, it causes the relay to open its contact and this throws the signal to stop, by gravity. It is impossible for the signal to be clear when a train is in the block. The track relay control is the keystone of the whole system of automatic block signaling.

Automatic block signaling is considered by some, who have not carefully investigated the matter, as too costly to warrant its installation, but those who have had experience with it know that it will soon pay for itself, not necessarily from the standpoint of safety alone, though, of course, the saving of one wreck may pay for two or three block systems, but principally because it enables the operating department to get the maximum carrying capacity for trains out of the track with safety and facility. The installation of an automatic

block signal system will often so increase the train capacity of a stretch of track as to render unnecessary the installation of another track.

The power for operating automatic block signaling systems, as has been said, may be obtained either from batteries located directly at the signals, or from a power transmission system running along the right-of-way. The battery system has been in vogue until about the last five years; these batteries, consisting of sixteen cells at each signal, require a good deal of attention in that the signal maintainer must examine the batteries periodically, clean them out and renew their contents. In this system, batteries are also provided for the operation of the track circuit which controls the track relay and these batteries have to be constantly attended to. The electric current fed to the track circuits is direct current, and with trolley roads in the vicinity, current leaking from the trolley return rails may interfere with the track relay controlling the steam railroad's signals. The signal may, therefore, stand in the proceed position falsely.

For these reasons, there has been an increasing use of the alternating current in signaling systems, and it is considered standard for all important installations. It has the advantage that it is entirely free from battery and foreign current troubles. Hence, aside from the increased safety, the actual expense for maintaining an alternating current system is less than in the case of the direct current system. There are cases where one man takes care of from 30 to 50 miles of alternating current automatic signals and two or three small interlocking plants in addition. The alternating current system has come into general use, because it is safer than the direct current system, and because it is cheaper to maintain.

One of the most recent developments in the signaling field is the use of light signals for day as well as for night indication. There are certain signal engineers who believe that the next ten years will see the general adoption of light signals in place of semaphore signals.

The light signal consists of a sheet iron or cast iron case carried on a pole and having two or three colored lenses illuminated by incandescent lamps behind them. When, for example, the red lens is illuminated, it indicates that the block immediately ahead is occupied. When the yellow lens is illuminated, it indicates that the first block in advance is clear, but that the second block in advance is occupied. When the green lens is illuminated, it indicates that both blocks ahead are clear. Such a light signal corresponds exactly to a three-position semaphore.

There is another system of light signaling in which a steel background, fastened on a signal mast, acts as a background for three rows of electric lights. One row projects horizontally, another in a line 45 degs. from the horizontal, and the third vertically, all radiating from a common point. By means of a three-contact track relay, such as is used in the ordinary semaphore block system, the horizontal row of lights may be illuminated to indicate stop, the 45-deg. row may be illuminated to indicate caution, and, when the vertical row is illuminated, it indicates that two blocks ahead are clear, and that the enginemen may go ahead at full speed.

In all light signals, the indication is given by day and by night with lights alone. Light signals have the obvious advantage that there are no moving parts or complicated mechanisms involved. They consist merely of a cast iron or sheet iron case with lenses, and back of those lenses are electric lights. There are no motors, and no moving parts to wear out. In certain locations, light signals actually have an advantage over semaphore signals, as in the case of electric roads where there is a network of overhead wires; in such cases, semaphore indications may not be entirely satisfactory, because the view of the semaphore blade may be obstructed by this overhead work. On the other hand, the light signal shows up well. In general the feeling in this country to-day is that the light signal has very distinct advantages, but it remains to be seen whether it will meet all conditions.

Finally, as to automatic stops. A great deal of work has been done and a great deal has been written, and more has been said, about automatic stops. An automatic stop is a device to automatically stop an engine, both by shutting off steam from the throttle and by applying the brakes, in case the engineman, for any reason, tries to run past a danger signal. Many impracticable schemes have been suggested for automatic stops, but no fully satisfactory one for all the varying conditions on steam railroads has yet been found. The patent office is full of plans for automatic stops. Nearly everybody who thinks of an idea plans to patent it. Most of these patents are not worth very much.

These things make it appear to Mr. Harold McCready (the author of the paper from which this short resume is taken) that when it comes to the spending of money on stop signals, the wiser course appears to him to be to expend it on some already known and tried system, on the ground that there are thousands of miles of railroad track which are not now protected in any way.

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The Difficult Maintenance of Beach Track

By JOE RODMAN

Conditions Met in Maintaining Track on Sand and Methods Used Successfully

In addition to the various ills to which track under normal conditions is subject, the trackman in charge of beach track has to deal with shifting sand, high tides, and the rapid deterioration of steel and fixtures from the erosive action of fogs, damp salt-air, and the salt-impregnated beach-sand that cannot be prevented from drifting over, and covering the base of the rail, the spikes and the tie-plates.

When the sand is in a dry state, a wind of not more than 6 miles an hour velocity is sufficient to set it in motion, though so slowly and gradually that a small force of laborers may easily prevent it drifting over the ball of the rail. During the spring and autumn months the worst winds prevail, and the sand being dryer, drifts much more rapidly than at other times. During the heavier and more protracted wind-storms each train is accompanied by a gang of shovelers who ride on the front end ready to remove the drifts if they interfere.

The most troublesome drifts are those that form between the higher dunes, especially when there is one on each side of the track about in line with the course of the wind. Not only does the first obstruction break the current of the wind and cause the floating sand to swirl and eddy into spits over the nearer track or rail but the air in the intervening space being static, the drift forms over the entire quiescent area between the two dunes covering both rails, or both tracks, equally.

The dunes themselves are continually varying in size, form and position. A salt weed springs from a stray seed in the flat, and the sand piles around it as it grows. As the growing weed branches out and gains in height, the sand dune increases in diameter and height until

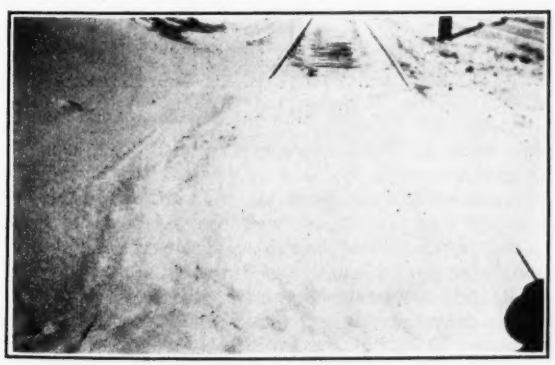
often a small mound is formed, which, if near enough, persistently encroaches on the track. However, as a measure of compensation, the wind will at times most unaccountably attack a dune that has long withstood its forces and, seeming to concentrate a spiteful en-

A "Tumble" Weed Starting a Drift

ergy on it alone, will steadily remove its drying surface until not a vestige remains on the spot.

Of the several lines laid in the sand wastes of the Southern California coast, the Pacific Electric has by far the most difficulty with the shifting sand owing to its greater mileage along the beach, its proximity to the ocean, and its more frequent service. Often, during the more severe storms, its otherwise good service has been interrupted for several days at a time, the trains being able to make not more than five miles an hour through the drifting sand. In shoveling the trains through, the sand is cleared only to the ball of the rail; and frequently before the train can get up to the shovelers, the rail becomes again covered enough to "ground" the motor, after which it is necessary to make a contact by holding a shovel or other metal tool between the rail and one wheel until a stretch of naked rail is reached.

Various schemes for plowing the sand were tried but without success until V. B. Radcliff, a roadmaster on this railway, perfected a simple plow of a bridge stringer and a pair of ballast shoes, which, like most simple and effective expedients, was tried only after more com-



Track Buried in Drifted Sand

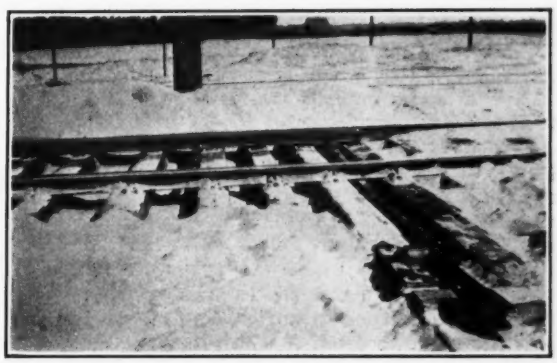
plicated schemes had failed or were discarded because of their impracticability. The accompanying illustrations show the simplicity of the plow construction and the "before and after taking" conditions of the track.

Like an ice flanger, it is necessary to lift the plow over switches, cattle guards, etc., and that necessitates a small gang of laborers to make the various adjustments; but compared to the former cost of removing sand from the track by hand after each storm, the small cost of the few laborers, motor and crew is inconsequential. It has been roughly estimated that the plow and motor accomplish more at a cost not exceeding twenty-five dollars than could be done by one hundred and fifty shovelers in a full working day.

The action of drifting sand resembles that of snow in that the fills are swept bare while the cuts are filled accordingly as their banks break the air currents. Various plans of obstruction after the manner of snow fences were tried but with little effect save to form new dunes extending nearer the track and causing the sand to fill the faster. Often, in the course of one sand storm, a "tumble weed" becoming lodged near the track will cause the formation of a new dune, as in the illustration showing the tip of a weed protruding from a newly-formed drift in the track.

Dirt, stone waste or a coating of crude oil placed on the shoulders of the fills will prevent undermining; but no remedy has so far been found for sand in the cuts save to fight it until the storm subsides. Raising the track has been proposed; but as the sand promptly rises to meet the level of any obstructioin, the increased elevation would afford only temporary relief.

Tide experts declare that a shell no larger than a pea



A Switch Cleaned After a Sand Storm

may change an ocean current. However that may be, it is none the less enigmatic to the beach trackman that the ocean will suddenly cease its attack on an almost vanquished embankment and transfer its forces to a place previously immune and consequently unprepared, but probably making some amends by refilling the weakened spot.

"The sea recedes; force triumphs over force;
Crumbles the shore; the waves their vict'ry chant."

Like the poet, the trackman applies some very descriptive language to the same theme, and the same intensity of his feelings directs him to remand it to a place where, if popular belief be true, it would be enthusiastically welcomed.

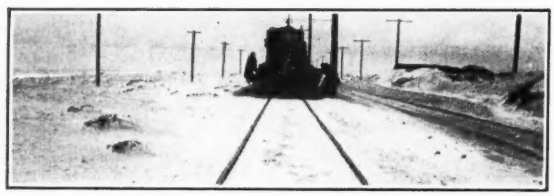
Less than three years earlier the track shown in another illustration was fully two hundred feet from the actual beach, and the sand dunes, which at that time intervened, were in places fifteen feet higher than the track grade. Apparently about the same amount of sand washed from this spot was deposited about two miles farther along, making safe a previously weakened spot, that is, safe until a reverse change takes place.

After a great deal of inconvenience, expense and delay to traffic, the difficulty was solved by a section foreman who, before his installation on that section, had never so much as seen the ocean. Instead of following the usual method and placing orders for carloads of heavy stone, he, at a very small expense, graded

the readily available sand into a long, gentle slope inclining toward the breakers. After each high tide he would rebuild the toe of his slope, leaving no breast for the next tide to undermine; for, as he picturesquely expressed it, "How's she going to bite anything off when she can't do nothing but fall back on herself?"

After several months of high tides and ground swells mounting his slope, and falling gently backward, spent and harmless, his track is intact. So far, "she ain't bit anything off."

Gauging and re-spiking require a great deal of the beach trackmen's time. Pockets or slots, in places, an inch in width are rusted from the sand-covered base of the rail at the point of spike contact. At the same time, the spike is rusting away; and when the flanges thrust the rail it is gradually opened or pushed outward to a

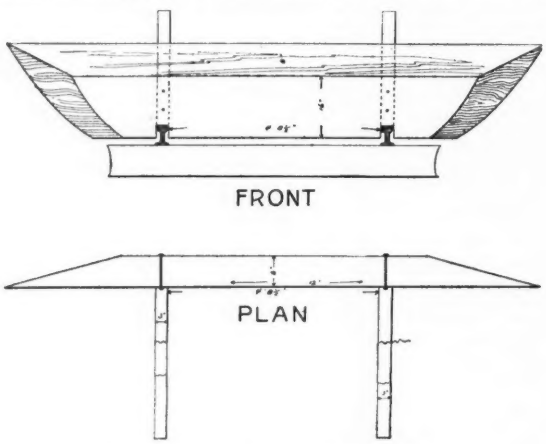


The Sand Plow Bucking a Light Drift

new contact. It was probably under such circumstances that the traditional foreman wrote to his roadmaster for "a gauge that would fit the track"; for, certainly 4 ft. 8½ in. seems entirely too narrow for long stretches of sand track.

Frequently a spike is withdrawn so rusted that when tapped with a maul or beaten over the rail it will scale away until a core of solid material not thicker than a telephone wire remains. The old-style ribbed tie-plates last barely three years, after which only a few thin strands, remaining where the ribs were formerly imbedded, are held in place by the rail.

To remove a track bolt after the first year of service, it is necessary to break it with a maul or cut the burr, which is so tightly "rust-welded" to the bolt that they

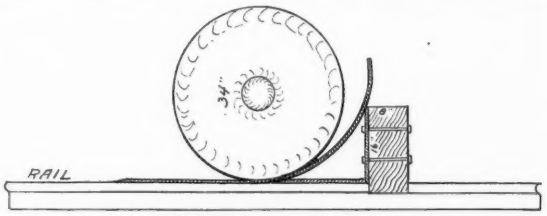


Front View and Plan of Sand Plow

are as one piece. In releasing old angle-bars, frequently they are bent into the shape of a horseshoe before they lose their grip on the rail.

Ties, on the contrary, seem to gain in length of life. Untreated redwood ties that have been covered in the sand for a dozen years or more, with remarkably few exceptions, seem to be as serviceable as when they were applied. What few tie renewals that have been necessary have been almost entirely due to the tie plate having rusted away, allowing the rail flanges to cut into the tie and weaken it so that the end became broken off at the point of stress.

With the exception of the upper parts of the switch stands they are never oiled on the beach track because



Side View of Sand Plow

of the certainty of their gumming from the mixture of oil and sand. The slide plates and other fixtures are at intervals "scaled" with a chisel in much the same manner that rust is removed from the sides of a steel ship when docked for painting.

Besides actual shelter the only protection against rust for angle bars, continuous joints, tie plates and other extra material on hand is to paint it lightly with crude oil which, with the finer sand that adheres to it, forms a hard and stable film that will protect the metal for a year or more. All supplies of the same nature are also piled cup downward so that they retain as little moisture as possible from the frequent fogs, rains and blowing spray. Even with the precautions taken, often the plates or continuous joints must be heated slightly and beaten clear of rust before they can be made to fit the rail.

For heavy rail beach-sand is splendid ballast, as the stiffness of heavy steel prevents it from surface-bending while its resiliency is sufficient to insure its automat-

"So Far She Ain't Bit Anything Off"

ically tamping itself after each slight depression from traffic stress; and the sand packing but little below the ball of the rail tends to retain it in fair alignment. On steel sixty pounds to the rail and lighter, the general surface is not difficult to maintain, but the dry, powdery sand "pumping" beneath the joint-ties allows the lighter rail quickly to surface-bend from quarter to joints which, despite frequent raising, retain a bad surface from the downward thrust of the bent rails and angle bars; and, of course, where surface is irregular a good alignment cannot be maintained.

In short, any rail too heavy and rigid to bend under the traffic stress will retain good surface and line on beach sand while a rail light enough to surface-bend under the same conditions will thrust the rounded and uniform grains of sand outward and away from the synclinal in ratio to the angle of its dip. Naturally the surface-bent joints become steadily worse and impossible to surface by ordinary methods. How the diffi-

culty was finally overcome is a subject worthy of treatment in a separate article.

With all the extra work essential to the maintenance of beach-track there are also reciprocating conditions. Save where an embryo sand-dune is beginning to form around the nucleus of a weed, there is no weed cutting;

High Tide Undermining Beach

the native sand-ballast being instantly permeable, no elaborate drainage precautions are required; and the dressings of track for either service or appearance is futile and, consequently, not considered necessary.

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Methods of Creosoting Douglas Fir

Effect on Strength of Timbers of the Temperature and Pressure Used in Treating

In some experiments made by Mr. O. P. M. Goss, while in charge of the Seattle Timber Testing Laboratory it was found bridge stringers, treated by the boiling and steaming process, lost from 33 to 35 per cent of their original strength. In an endeavor to eliminate this result and yet retain the preservative features produced, a large number of experiments have been made, with this end in view. There are two general classes of structural timber. Those that must retain their full strength after treatment, and those where protection is of primary importance and strength is secondary.

Mr. Goss, who is connected with the Forest Service, has offered some observations on this question at a recent meeting of the American Wood Preservers' Association. He says in substance:

No difficulty has been experienced in handling the second class of material, that where strength is secondary. The trouble has been entirely with the first class. It has been possible to secure a good oil penetration by both the steaming and boiling processes. From experiments which have been made it has been shown that high temperatures and high pressures in these treatments are largely responsible for the loss in strength of the wood. The treatments used in the past have been applied, something as follows:

In the boiling process the timbers were placed in a retort in green condition, and boiled in creosote oil under atmospheric pressure for 22 to 24 hrs. at a temperature ranging from 230 to 260 degs. Fahr. This boiling period was used to season the timber and prepare it for receiving the oil. After the boiling period, pressure was applied, rising from zero to as high as 145 to 185 lbs. per sq. in. The pressure was continued over a period of 4 to 6 hrs., at a temperature of approximately 180 to 230 degs. Fahr. By this method, 10 to 14 lbs. of oil per cu. ft. were injected into the wood.

In the steaming process the timbers were placed in the retort in a thoroughly green condition and steamed at 90 lbs. pressure per sq. in. for 4 to 7 hrs., at a temperature of approximately 325 to 335 degs. Fahr. A vacuum of approximately 20 ins. was then applied for 18 to 20 hrs. while the temperature ranged above 220 degs. Fahr. At the end of the vacuum period creosote oil was introduced and pressure applied, rising from zero up to 160 lbs. per sq. in. This pressure period continued for 2 to 4 hrs., at a temperature of approximately 208 degs. Fahr. Ten to 14 lbs. of oil per cu. ft. of wood were usually injected into the timber by this process.

In both these processes high temperatures were applied. The temperature used in boiling was lower than that used in steaming, but was applied for a longer time.

In recent experiments both temperatures and pressures have been reduced and the vacuum made to take a more important part in the process. The most successful treatment yet devised for treating bridge stringers and similar forms without loss in strength is that of boiling in vacuum. When green timbers are creosoted by this method the treatment requires approximately 26 hrs.

When boiled in vacuo the timbers are placed in the retort and creosote oil introduced at a temperature of 160 to 180 degs. Fahr. Heat is applied, and the temperature of the oil gradually raised to 190 degs. Fahr. and held at that temperature for 5 to 6 hrs., which is a sufficient length of time to warm the timbers through.

When the timbers are thoroughly warmed, a vacuum of 24 to 27 ins. is produced on the oil, still holding a temperature of 190 degs. Fahr., this vacuum formed through an overhead pipe extending from the top of the retort for 36 ft. vertically into the air and returning to the condenser. The purpose of this pipe is to prevent the creosote oil from passing over into the condenser while boiling under vacuum. This vacuum begins at 16 to 18 ins. and as the timber seasons it is gradually raised to 24 to 27 ins. The full period for which the vacuum is applied is 12 to 16 hrs. It is continued until the rate of seasoning of the timber is 0.1 lb. of water per cu. ft. of wood per hour. After this finished rate of seasoning is reached, the vacuum is broken and pressure on the oil is started, which rises as high as 120 to 135 lbs. per sq. in. and continues over a period of 4 to 6 hrs. The temperature of the oil during the pressure period drops from 190 to 180 degs. Fahr. By this process 10 to 14 lbs. of oil per cu. ft. may be pressed into the wood.

This method of treatment is a modification of the Boulton process, and at the low temperatures used seasons the wood even better than the old boiling process which employed much higher temperatures. Timbers treated by the method are noticeably easier to press than timbers treated under the old boiling process. The edges of the checks which develop, due to seasoning, are very sharp, showing that the wood is not burned at all.

In order to carry the test still further, and to determine the effect of this treatment upon the strength of Douglas fir bridge stringers, two shipments of full sized stringers were selected, and treated in four different charges at the plant of the St. Helens Creosoting Co. These stringers were of three sizes, 7 x 14 ins. x 28 ft., 7 x 16 ins. x 30 ft. and 10 x 14 ins. x 28 ft. They were carefully selected so that the two halves were of equal quality, cut in the center, and one-half creosoted and tested, and the other half tested in its natural green condition. The 7 x 14 in. and the 10 x 14 in. stringers

were tested on a 13-ft. span, and the 7 x 16 in. stringers were tested on a 14-ft. span.

All stringers were tested under one-third point loading. The strength tests were made on the treated material within approximately 10 days after date of treatment. The untreated stringers were tested in a green condition. All tests were made by the Bureau of Standards, Portland, Ore., in accordance with United States Forest Service standard methods, and a complete report rendered on the tests.

The 7 x 14 in. stringers, based on the modulus of rupture, showed the average strength of the timbers treated to be 101.2 per cent that of the natural. In three sets of these stringers the treated showed less than the natural, while in six tests the treated showed greater strength than the natural.

As regards the modulus of rupture, the fiber stresses at elastic limit, and the modulus of elasticity, the results of the experiments show that treated and natural stringers are very close together for these factors. The results as set down in this paper prove that Douglas fir bridge stringers can be effectively creosoted without injury to their strength, a fact which is particularly interesting to the railroads as well as consumers of structural timber.

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The Psychology of the Crossing Road

Aparatus Used at Highway Crossings by the C. & N. W., the Long Island, the Southern Pacific and Others

Railroad companies have been menaced from their earliest days with the possibility of the road-crossing accident, and many ways have been tried in the effort to prevent injuries and loss of life. The most effective way has been to depress the highway or elevate the railroad track. Where this has not been feasible or has been too expensive, other means have been adopted; among these is the electric alarm bell and the road-crossing watchman.

On the Chicago & Northwestern the watchman has

New York Central. Highway Crossing Lamp

been supplied with a round disc painted white with the word "Stop" in black upon it. The watchmen have been advanced to the rank of railroad policemen and are therefore empowered to make arrests. The Long Island Railroad uses striped gates, and banks of earth and clumps of trees which obscured the track have been leveled and cut down so that automobilists and others have no excuse for asserting that a concealed crossing was in their path.

The New York Central not only use the discs as stop

Crossing Watchman with Disc. N. Y. C.

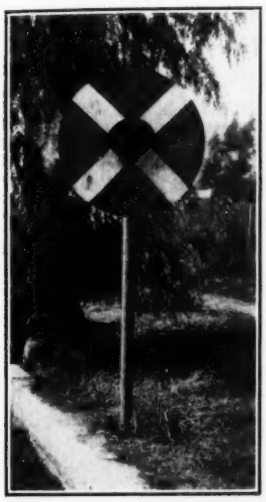
signals for warning automobilists, but they are now trying a form of lamp for the same purpose at night. The whole matter with them, as with others, is in the experimental state, and they do not feel that they are committed to any particular form or color in the way of warning signals. The advantage of the watchman's disc over the usual flag is that it cannot be fluttered in the wind, and can never appear "on edge" to the driver of a vehicle, and is not likely to attract the eye of enginemen or emphasize to them the stop indication.

The lamp is a combination of an ordinary standard railroad lantern, which if broken or defective can be removed from the long case, which is intended to re-

N. Y. C. Automobile Signalled at Crossing

strict rather than concentrate the light. At present the N. Y. C. are using a red glass with the word "Stop" upon it, but the objection to red is that it might unintentionally be shown to an engineman, with the result that an unnecessary application of brakes might take place. This road in the person of its general safety agent, Mr. Marcus A. Dow, is making what might be called a working test in order to arrive at a trustworthy conclusion as to the most suitable devices and colors and the most effective methods for reducing the casualties at highway crossings. It is an honest endeavor, carried out intelligently and with care, having the almost paternal quality of endeavoring to protect a user of the highway against himself.

The Southern Pacific Company have with the personal supervision of Mr. W. R. Scott, vice-president and general manager at San Francisco, Cal., devised and put in operation a distant signal for automobilists for use at highway crossings. The signal is placed some distance from the actual crossing and is designed to give anyone approaching advance information as

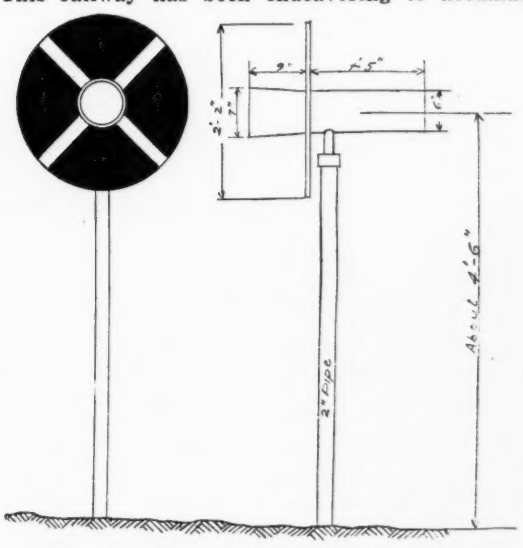


Front View

Side View

to whether or not the train is coming. The red light, which is inside the cylinder-like portion of the signal, is lit up when a train is within about 2,000 ft. of the crossing, and approaching automobilists would therefore not necessarily stop at the signal, but would have positive knowledge that a train was approaching and would, in the majority of instances, go on up to the crossing itself before stopping.

This railway has been endeavoring to accumulate



Southern Pacific Crossing Warning Device

definite information as to the benefits derived from the use of the signal, and while they are sure that it is a great help, yet are unable to furnish any statistical information as to the extent of such benefits for the reason that the actions of the automobilists and others passing the apparatus would depend largely on whether or not the individual is thoroughly familiar with the crossing. For instance: a stranger would, upon seeing the signal, probably slow up and take such heed of it as would be noticeable to an observer, while one familiar with the signal and its location would pass it with a glance, the one watching his behavior would be unable to determine whether it was even seen. The approximate cost of the apparatus is $40. Other roads, as we said, use an electric alarm bell at crossings.

The signal here described is a good example of the painstaking and scientific effort to apply an adequate remedy to what is a serious menace to human life. The whole question is as yet in an indeterminate state and the railways are compelled to approach it with the heavy handicap that the law is of questionable assistance to them, and they are without means of applying any discipline to even wanton offenders, as they might, if there own employes were involved. It is said that the municipal law of Paris holds that in an automobile accident it is considered to be prima facie evidence of the carelessness on the part of the foot passenger, if he is hurt. This has very greatly reduced the number of such accidents in the streets of Paris. A person injured by an automobile when crossing the

S. P. Co. Highway Crossing Warning Signal

street cannot succeed in an action in court unless he is able to establish, beyond peradventure, that he was run down by the most flagrant and, one might almost say, malignant carelessness of a chauffeur. The law gives the road to the automobile and the sidewalk to the pedestrian, and while the right to cross is not denied to the walker, he must do so largely, if not wholly, at his own risk.

The root of the crossing evil, especially in this country, is psychological to a far greater extent than is generally recognized. The numerous epithets hurled at automobilists who try to cross railroad tracks are more or less wide of the mark. We are here confronted not by a theory, but by a condition. The railroad companies who are endeavoring to combat the evil have got to the point where they recognize the condition and are doing the best that can be done in approaching the subject, with what means they can command.

When the psychological aspect of the matter is considered, it must be remembered that this does not involve any of the comparatively meaningless speculations which were dependent on philosophical or theological modes of thought which had no relation to the ordinary affairs of daily life. The modern science no longer wanders in the labyrinth of speculation about the soul. Applied psychology will more and more be compelled to place its experiments and state its views to the expectant world of industry and commerce. The concrete case before us does not involve a knowledge,

however fragmentary, of Kent's categorical imperative or the postulates of experience. What everyone would like to know is why the simple knowledge of a railway track in front of a chauffuer does not operate to produce any evidence of caution on his part, and further, why with gates, signals, watchmen, the risk of accident is not only not eliminated, but only partly reduced.

No explanation that leaves out the psychology of the phenomenon can hope to reach a definite and final result. The words careless, reckless, speed-fiend, irresponsible motorist, and others of like import, do not either express what actually exists, but they tend to produce only an empty, though wordy, outburst between the parties. Help may be gained in throwing some light on the subject, if the efforts of the modern, practical theory of experimental and applied psychology are brought to bear upon the case. There is no abnormal action, and no accident in industrial life, whether on or off a railway, which is not within the scope of this newly developed science, and to ignore it is but to set back the hands of the clock.

The love of what we call reckless speed in the joy rider may have had a perfectly legitimate origin in the long-past days which saw the early genesis of the race. Bergson points out that in the very dawn of life the animal and plant divided on the necessity to move, and the ability to stand still and live. The development of movement went on in animal life until complete differentiation of the animal and vegetable kingdoms was complete. Mobility was gaining headway, when a serious halt occurred. The animal was compelled to resort to all kinds of heavy defensive armor to resist attack, of which the shells of molusks, the heavy, tough skin of the saurians, the carpace of the glyptodons and their allied species, and the hard, bony case of ganoid fishes are all examples of the method of defense which checked the mobility of the animal without destroying its slowly acting and eventually triumphant instinct and desire for rapid motion and the joy of speed. The primal instinct is thus revealed. Its fulfillment is today. The desire in some form persists.

In more modern times the influence of mental interference has been studied and throws a certain light on the whole matter. We are told that we cannot ignore the many side influences which hasten or delay, improve or disturb the acquisition of industrial skill. It seems to be detrimental in some way to the enjoyment of the gratified instinct for rapid motion to submit it to an interruption. Such an interruption is clearly in view at a railway crossing and instances have been noted where drivers have approached a crossing with gates down and red flag and light displayed and have preferred to make a detour over rough ground and go around the end of the lowered gate and gain the road beyond with a brief margin for safety, rather than undergo the mental exertion involved in a halt, a pause, and a fresh start. Any interruption presupposes a special effort and this is distinctly irksome, if by constant driving and practice a chauffeur has been able to reduce his work on a motor car to the almost automatic act of steering while gliding along a smooth road at a rapid pace.

We have not, by these remarks, sought to exonerate the driver of a machine, but rather to emphasize the handicap to effective advance which weighs down the railway in its laudable effort to preserve life and property and to protect a man against himself. Suppose the gates, the flag and the lights are seen. How long will they consciously act on the observer? There is no settled state of consciousness, any more than there is no place where an arrow is when it flies. The attention of the driver subject to distraction must be arrested and held. How best to do this is the problem. The question of taking risk is perhaps to the chauffeur the deepest question that can ever be asked of him, and the reply cannot be couched in words, it must and can only be answered by the dumb turning of the will, followed by the necessary and saving act.

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Railway Signal Association Program Reports of Committees

For Discussion at Stated Meeting, Auditorium Hotel, Chicago, Ill., March 20, 1916

Time of Meeting

Morning session—9:30 a. m. to 1 p. m.
Afternoon session—2 p. m. to 5:30 p. m.

List of Subjects

Committee I—Signaling Practice.
- Exposition of the Three Schemes of Signaling.

Committee II—Mechanical Interlocking.
- Requirements for the Protection of Traffic at Movable Bridges.
- Revision of Specifications for Mechanical Interlocking.
- Drawing 1400—Leadaways—Turn in Pipe Run with Cranks.
- Drawing 1401—Leadaways—Turn in Pipe Run with Deflectors.
- Drawing 1402—Leadaways—Turns in Main Pipe Run.

Committee III—Power Interlocking.
- Typical Drawings for Electro-Pneumatic Interlocking as follows:
  - 1147—Single Switch with Electric Detector Bar.
  - 1148—Three-arm Selected Signal.
  - 1158—Single Switch Circuit.
  - 1159—One-arm Signal Circuit with Line Control for Distant Signal.
  - 1160—Section Locking for Crossover.
  - 1161—One-arm Signal Circuit with Polarized Control for Distant Signal.
  - 1162—Section Locking for Single Switch.
  - 1163—Signal Circuit, showing Selection through Switch Levers and S. S. Indicators.

Committee VI—Standard Designs.

Revised Drawings

1035—Signal Masts.
1059—Clamp for Base of Ground-mast Signals.
1073—Details of Transverse Pipe Carriers.
1197—Two-lever Wall Machine.
1226—Stuffing Box for Wire.
1236—Two-way Single-Lamp Signal.
1360—Tang Ends with Screw Jaws.
1397—Two-lever Wall Machine.

New Drawings

1235—Semaphore Spectacle—Design "C."
1355—Crank Bearings and Clamps.
1356—Double Spectacle Bearing and Lamp Bracket.
1357—Ladders for Two-way Single-lamp Signal.
1399—Low Target Stand.

Committee IX—Wires and Cables.
- Definitions of principle terms used in Wire and Cable Specifications.
- Specifications for Steel Cored Aluminum Stranded Aerial Cable.

Committee X—Storage Battery and Charging Equipment.
- Specifications for Lead Type Portable Storage Battery.

Specifications for Composite Stationary Storage Battery.
Drawing 1175—Hydrometer and Thermometer.
Drawing 1248—Portable Storage Battery.
Special Committee—Electrical Testing.
Method of Testing Apparatus for Circuits—Progress Report.
Drawing—R. S. A. 4-Track Circuit Test Chart.
Drawing—R. S. A. 5-Test Chart for Insulated Joints.
Special Committee—Lightning Protection.
Requisites for Ground Connections for Lightning Arresters.
Requisites for Applying Ground Apparatus.
Harmonizing Committee—General Provisions of Specifications for Signal Installations.

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American Railway Engineering Association Program Seventeenth Annual Convention

Order may be changed by a two-thirds vote of convention, or by time required for consideration of reports. Morning session, 9:30 a. m. to 12:30 p. m.; afternoon session, 2 p. m. to 5 p. m.; evening session, 7:30 p. m.

First Day—Tuesday, March 21st.

President's address.
Reports of Secretary and Treasurer.
Reports of Standing and Special Committees.

X.	Signals and Interlocking	Bulletin 181
IX.	Signs, Fences and Crossings	Bulletin 181
XIII.	Water Service	Bulletins 181, 183
XV.	Iron and Steel Structures	Bulls. 178, 181, 183
VII.	Wooden Bridges and Trestles	Bulletin 182
VIII.	Masonry	Bulletin 182

Evening Session

Illustrated paper on "The Nick and Break Test in the Inspection of Steel Rails," by Robt. W. Hunt.
Illustrated paper on "Test of Douglas Fir Bridge Stringers," by H. B. MacFarland.

Second Day—Wednesday, March 22d

III.	Ties	Bulletin 182
XIX.	Conservation of Natural Resources	Bull. 182
XIV.	Yards and Terminals	Bulletin 182
Special.	Uniform General Contract Forms	Bull. 182
Special.	Stresses in Railroad Track	Bulletin 182
XII.	Rules and Organization	Bulletin 184
I.	Roadway	Bulletin 183
II.	Ballast	Bulletin 183

Annual Dinner at 6:30 p. m.

Third Day—Thursday, March 23d

V.	Track	Bulletin 183
VI.	Buildings	Bulletin 183
XVIII.	Electricity	Bulletin 183
Special.	Grading of Lumber	Bulletins 174, 183
XI.	Records and Accounts	Bulletin 183
XVII.	Wood Preservation	Bulletin 184
IV.	Rails	Bulletins 179, 184
XVI.	Economics in Railway Location	Bulletin 184

New business.
Election and installation of officers.
Adjournment.

Members are requested to register on arrival in Room 1166 of the Congress Hotel, and receive a badge, program and other convention literature.

Members are also requested to bring the Bulletins containing committee reports to the convention, as the supply of extra copies is limited. Additional copies of Bulletins containing committee reports may be procured by members during the convention in Room 1166 at cost.

Reservations for the annual dinner can be made beginning Tuesday noon, on the second floor of the Congress Hotel.

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Railway Telegraph Superintendents Meeting

The Western division of the Association of Railway Telegraph Superintendents will hold their March meeting in Chicago, Wednesday, March 22, 1916, in the Red Room on the nineteenth floor of Hotel LaSalle, at LaSalle and Madison Sts. The meeting will be called to order at 9:30 a. m. and at 12:30 a luncheon will be served. The subject matter announced for the meeting includes preliminary and informal reports from several chairmen of standing committees; a discussion of experiences and preventive measures dealing with the interruptions to telegraph and telephone service resulting from recent sleet storms and cold waves; a discussion of other sources of current supply than gravity batteries, and a question box for subjects apropro and of interest, which may be mailed or handed to the secretary before the meeting. An afternoon session will be held if considered advisable. Any further information may be secured from the secretary, R. W. Potts.

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The Creepage of Electricity

In describing the motors used on the C. M. & S. P. electrification, the company pointed out that the "creepage" distance was exceptionally large. In explanation of this word "creepage" when used in connection with electrical installations we may say that the voltage of electric power is analogous to pressure. This voltage, or pressure, is at all times tending to "break down" the electric conductors or circuits and return, completing its circuit without passing through the electrical apparatus such as machinery, light, heating coils, etc. This voltage will actually "break down" the atmosphere, and if two points, such as metal conductors, are brought sufficiently close together the electric currents will jump across the distance between these points, depending on the voltage used. The voltage must be comparatively high, for instance 11,000 volts will jump something like ¼ in. However, the creepage distance is a great deal more than this ¼ in., that is, the voltage on the conductors, if the conductors are in contact with surfaces such as wood, glass, tape or any similar material, will creep along from conductor to conductor over the surface of the material, the distance depending a great deal on the condition of the material, such as moisture or dirt. It is, therefore, necessary in the design of all electrical apparatus where there are conductors, such as the commutator of a motor with voltage impressed on it, that sufficient creepage distance between these copper conductors and the ground be allowed (in this case the frame of the motor), so that the current will not creep across, even although the material such as glass, wood, tape, etc., may be covered with moisture and dirt.

Reference to the creepage of the motors being spoken of as extraordinarily large simply means that these distances are probably greater than the standard allowance so that there will be practically no chance of creepage to ground and thus flashovers of the motors often with considerable damage to motors, machinery or cars, which would occur if the creepage distance was too small.

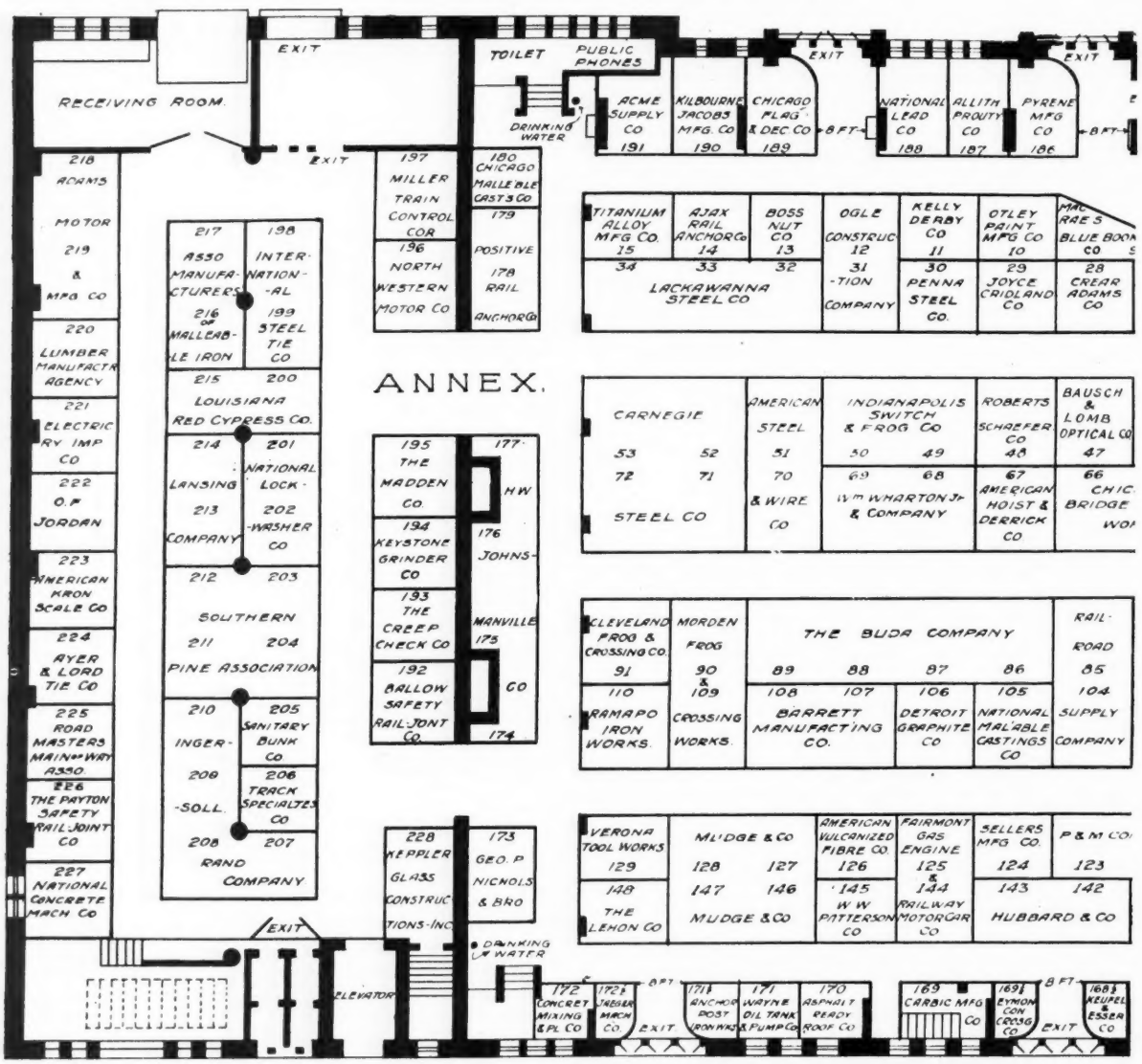
Supply Trade News

Directory of Exhibitors at the N. R. A. Convention, 1916

Enrollment Booth, National Railway Appliances Association, located on the north side of the Wabash avenue entrance of the Coliseum, in charge of the enrollment committee; J. L. Hench, Lackawanna Steel Co., Chicago, Ill., chairman; A. H. Kuerst, Detroit Graphite Co., Chicago, Ill.; A. R. Sutter, The P. & M. Co., Chicago, Ill.; Hubert Van Zant, Carnegie Steel Co., Chicago, Ill.; L. M. Mathews, Fairbanks, Morse & Co., Chicago, Ill.

Numbered badges will be used as last year and on the promptness with which the individual members of the association register and procure their badges depends to a considerable degree the value of the printed list of members with their badge numbers and hotel addresses, which will be issued Tuesday, including all names registered Monday.

Information Booth, National Railway Appliance Association, in the secretary's office on the south side of the Wabash avenue entrance of the Coliseum, will be maintained not only during the week of the exhibition but prior to and during the installation and dismantling of the exhibits. During this entire time there will be a competent person in attendance to give any necessary information to members.


RECEIVING ROOM
EXIT
TOILET
PUBLIC PHONES
DRINKING WATER
ACME SUPPLY CO 191
KILBOURNE JACOBS MFG. CO 190
CHICAGO FLAG & DEC CO 189
NATIONAL LEAD CO 188
ALLITH PROUTY CO 187
PYRENE MFG CO 186
8 FT
218 ADAMS MOTOR 219 & MFG CO
220 LUMBER MANUFACTR AGENCY
221 ELECTRIC RY IMP CO
222 O. F JORDAN
223 AMERICAN IRON SCALE CO
224 AYER & LORD TIE CO
225 ROAD MASTERS MAINT OF WAY ASSO
226 THE PAYTON SAFETY RAIL JOINT CO
227 NATIONAL CONCRETE MACH CO
217 ASSO MANUFACTURERS 216 OF MALLEABLE IRON
218 INTERNATIONAL STEEL TIE CO 199
215 200 LOUISIANA RED CYPRESS CO.
214 LANSING 213 COMPANY
201 NATIONAL LOCK-WASHER CO 202
212 203 SOUTHERN 211 204 PINE ASSOCIATION
210 INGER-SOLL 208
205 SANITARY BUNK CO
206 TRACK SPECIALTIES CO
208 207 RAND COMPANY
197 MILLER TRAIN CONTROL COR
196 NORTH WESTERN MOTOR CO
180 CHICAGO MALLEABLE CAST'G CO
179
178 POSITIVE RAIL ANCHOR CO
ANNEX.
195 THE MADDEN CO
194 KEYSTONE GRINDER CO
193 THE CREEP CHECK CO
192 BALLOW SAFETY RAIL JOINT CO.
177 HW
176 JOHNS-MANVILLE 175 CO 174
228 KEPPLER GLASS CONSTRUCTIONS-INC
173 GEO. P NICHOLS & BRO
DRINKING WATER
ELEVATOR
172 CONCRET MIXING & PL CO
172½ JAEGER MACH CO
171½ ANCHOR POST IRON WKS
171 WAYNE OIL TANK & PUMP CO
170 ASPHALT READY ROOF CO
169 CARBIC MFG CO
169½ EYRON CON CROSG CO
168½ KEUFEL & ESSER CO
TITANIUM ALLOY MFG CO. 15 34
AJAX RAIL ANCHOR CO 14 33
BOSS NUT CO 13 32
LACKAWANNA STEEL CO
OGLE CONSTRUC 12 31 -TION COMPANY
KELLY DERBY CO 11 30 PENNA STEEL CO.
OTLEY PAINT MFG CO 10 29 JOYCE CRIDLAND CO
MACRAE'S BLUE BOOK CO 28 CREAR ADAMS CO
CARNEGIE STEEL CO 53 52 72 71
AMERICAN STEEL & WIRE CO 51 70
INDIANAPOLIS SWITCH & FROG CO 50 49 69 68 WM WHARTON JR & COMPANY
ROBERTS SCHAEFER CO 48 67 AMERICAN HOIST & DERRICK CO
BAUSCH & LOMB OPTICAL CO 47 66 CHIC BRIDGE WOR
CLEVELAND FROG & CROSSING CO 91 110 RAMAPO IRON WORKS
MORDEN FROG 90 & 109 CROSSING WORKS
THE BUDA COMPANY 89 88 87 86 108 107 BARRETT MANUFACTING CO. 106 DETROIT GRAPHITE CO 105 NATIONAL MALLABLE CASTINGS CO
RAIL-ROAD 85 104 SUPPLY COMPANY
VERONA TOOL WORKS 129 148 THE LEHON CO
MUDGE & CO 128 127 147 146 MUDGE & CO
AMERICAN VULCANIZED FIBRE CO. 126 145 W. W PATTERSON CO
FAIRMONT GAS ENGINE 125 & 144 RAILWAY MOTOR CAR CO
SELLERS MFG CO. 124 143 HUBBARD & CO
P & M CO 123 142

South Half of Coliseum

Acme Supply Co., Chicago Ill.—Space No. 191. Exhibit: Gosso sanitary bed for bunk and construction cars, Acme steel diaphragm, Acme vestibule curtain outfit, Acme duplex weatherproof window, Kass safety step tread, Acme safety step box, Acme anti-pinch door shield, Acme crown curtain fixture, Acme protected groove curtain fixture, Regal revolving shade box, Chanarch steel flooring, Acme steel passenger car doors. Representatives: H. H. Schroyer, H. U. Morton, S. W. Midgley, R. C. Munro, E. B. Van Patten, W. J. Koons, A. E. Gosso, R. M. Smith, J. B. Smouse.

Adams Motor and Manufacturing Co., Chicago, Ill.—Space Nos. 218, 219. Exhibit: Railway Inspection Motor Cars. Representatives: W. E. Adams, N. W. Adams.

The Adams & Westlake Co., Chicago, Ill.—Space Nos. 83, 84, 102. Exhibit: Signal lamps, lanterns, long-time burners, Adlake center-core long-time burner wicks, switch locks, etc. Representatives: G. L. Walters, A. S. Anderson, C. B. Carson, J. F. Stender, H. G. Turney, Wm. J. Piersen.

Ajax Rail Anchor Co., Chicago, Ill.—Space No. 14. Exhibit: Ajax double grip rail anchors. Representatives: F. B. Bradley, H. G. Eefbarg, B. Hoffmann, G. N. Holmberg, G. F. Weiss.

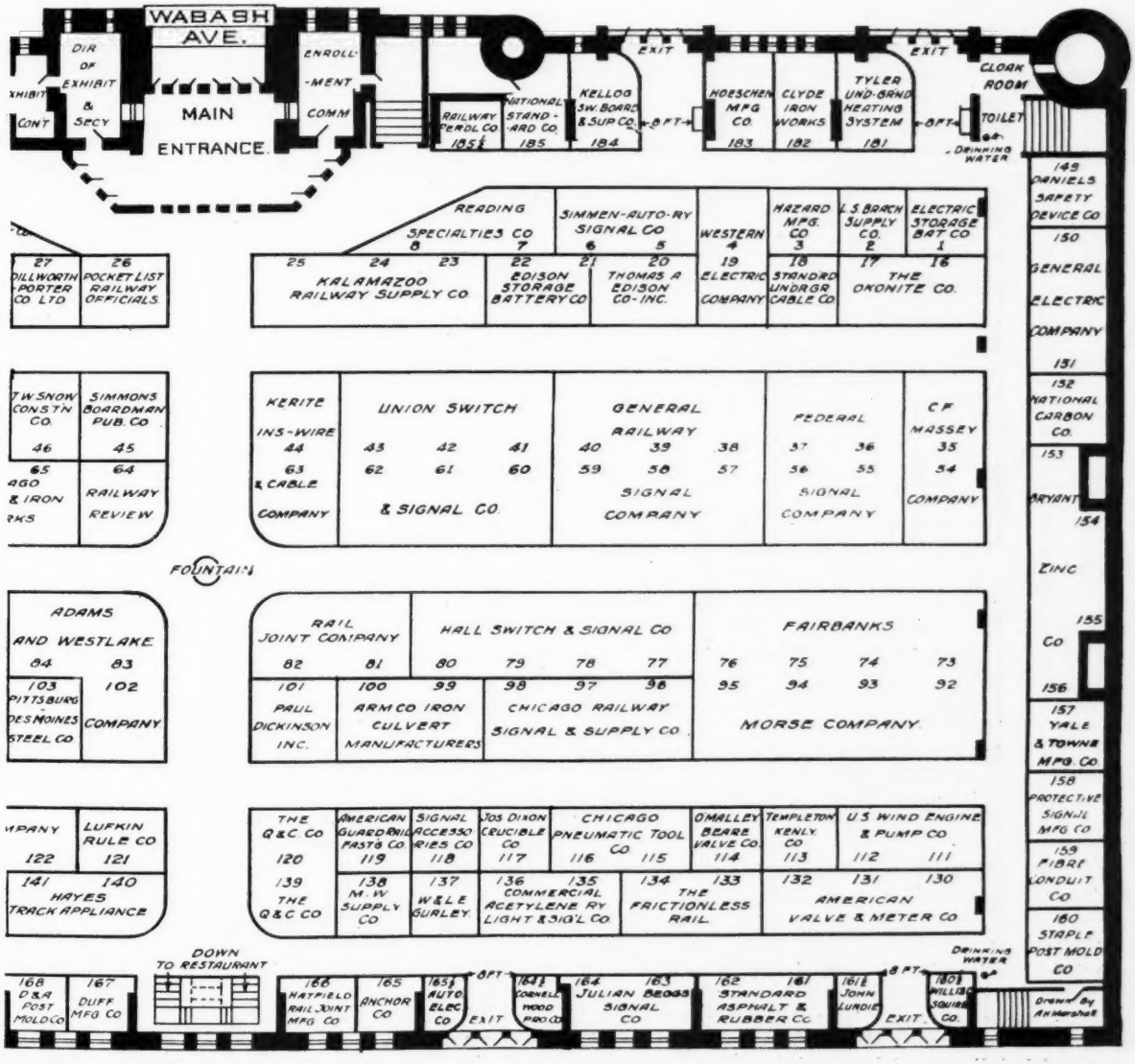
Allith-Prouty Co., Danville, Ill.—Space No. 187. Exhibit: Door hangers, spring hinges, rolling store ladders, overhead carriers, fire door hardware, hardware specialties. Representatives: H. R. Maxwell, A. V. Martin, F. B. Coates, H. C. Smith, D. E. Willard.

American Guard Rail Fastener Co., Philadelphia, Pa.—Space No. 119. Exhibit: Guard rail clamps, tie plate guard rail fasteners, rail anchors. Representatives: D. F. Vaughan, D. L. Vaughan.

American Hoist and Derrick Co., St. Paul, Minn.—Space No. 67. Exhibit: Large pictures of the "American" railroad ditcher. Representatives: F. J. Johnson, W. O. Washburn, W. L. Manson, C. C. Austin, D. L. O'Brien, Harold Washburn, J. L. Hickey.

American Kron Scale Co., New York City—Space No. 223. Exhibit: Kron automatic dial scales. Representatives: W. W. Camp, Ernst Ohnell, C. Larson, M. E. Fitzgerald, J. Kirk Rowell, E. M. Abramson.

American Steel and Wire Co., Chicago, Ill.—Space Nos. 51, 70. Exhibit: Railway right-of-way fences and


WABASH AVE.
MAIN ENTRANCE
DIR OF EXHIBIT & SPCY
ENROLL-MENT COMM
EXIT
CLOAK ROOM
TOILET
DRINKING WATER
RAILWAY PERCL CO 185½
NATIONAL STAND-ARD CO. 185
KELLOG SW. BOARD & SUP CO. 184
HOESCHEN MFG CO. 183
CLYDE IRON WORKS 182
TYLER UND-GRND HEATING SYSTEM 181
READING SPECIALTIES CO 8 7
SIMMEN-AUTO-RY SIGNAL CO 6 5
WESTERN 4
HAZARD MFG. CO 3
U.S. BORCH SUPPLY CO. 2
ELECTRIC STORAGE BAT CO 1
27 DILLWORTH PORTER CO LTD
26 POCKET LIST RAILWAY OFFICIALS
25 24 23 KALAMAZOO RAILWAY SUPPLY CO
22 21 EDISON STORAGE BATTERY CO
20 THOMAS A EDISON CO-INC.
19 ELECTRIC COMPANY
18 STANDRD UNDRGR CABLE CO
17 16 THE OKONITE CO.
149 DANIELS SAFETY DEVICE CO
150 GENERAL ELECTRIC COMPANY 131
152 NATIONAL CARBON CO.
153 BRYANT
154 ZINC
155 Co
156
157 YALE & TOWNE MFG. Co
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AMERICAN VALVE & METER CO
DOWN TO RESTAURANT
DRINKING WATER
168 D&A POST MOLD CO
167 DUFF MFG CO
166 HATFIELD RAIL JOINT MFG CO
165 ANCHOR CO
165½ AUTO ELEC CO
EXIT
164½ CORNELL WOOD PRO CO
164 JULIAN BROOKS SIGNAL CO
163 162 STANDARD ASPHALT & RUBBER CO
161 JOHN LUNDIE
161½ WILLIS SQUIRE CO.
Drawn By AH Marshall

North Half of Coliseum

gates, steel fence posts, wire rope, rail bonds, telegraph and telephone wire, signal wire, electrical wires and cables. Representatives: L. P. Shanahan, B. H. Ryder, F. A. Keyes, C. S. Wright, Jr.

American Valve and Meter Co., Cincinnati, O.—Space Nos. 130, 131, 132. Exhibit: Poage water columns; Fenner drop spouts; Anderson economy switch stands; Anderson quick repair switch stands; Anderson interlocking switch stands; Anderson safety switch locks. Representatives: J. T. McGarry, F. C. Anderson.

American Vulcanized Fibre Co., Wilmington, Del.—Space No. 126. Exhibit: Vul-Cot fibre for rail joints, steel cross tie, bridge and switch insulation, and fibre specialties. Representatives: C. C. Bell, Wm. Maxwell, H. P. Weldon, W. A. Jordan, H. E. Winn, John Barron.

Anchor Co., Chicago, Ill.—Space No. 165. Exhibit: Efficiency rail anchor. Representatives: T. B. Bowman, C. P. Williams.

Anchor Post Iron Works, New York City—Space No. 171½. Exhibit: Inter-track railing with special extra "D" channel rails; inter-track railing with rails and pickets electrically welded; right-of-way fence with extra "D" channel rails; right-of-way fence with rails and pickets electrically welded; right-of-way fence which can be graded or adjusted in the field to suit any slope; galvanized anchor posts and samples of chain link woven fabric, photographs and blue-prints. Representative: George W. Forster.

Armco Iron Culvert Manufacturers, Middletown, O.—Space Nos. 99, 100. Exhibit: Culverts, "Armco" iron railway products. Representatives: G. F. Ahlbrandt, B. G. Marshall, Howard See, John S. Roney.

Asphalt Ready Roofing Co., New York City.—Space No. 170. Exhibit: "Hudson" asphalt shingles, "Protection" brand roofing, "Arrow" brand roofing, red, green and gray "Rockland" roofing. Representatives: H. H. Huested, C. A. Sparrowhawk.

Associated Manufacturers of Malleable Iron, Cleveland, O.—Space Nos. 216, 217. Exhibit: Malleable iron castings and testing machines. Representatives: S. H. Standish, Frank M. Robbins, Mr. Fulton.

Automatic Electric Co., Chicago, Ill.—Space No. 165½. Exhibit: Train dispatching exhibit; automatic telephone switchboard in operation; supplies, lamps, cords, wire, etc. Representatives: W. N. Curtiss, W. N. Furthman, J. H. Finley.

Ayer & Lord Tie Co., Inc., Chicago, Ill.—Space No. 224. Exhibit: Interior creosoted wood blocks for shop floors, creosoted wood paving blocks, creosoted timbers, treated railroad ties, etc. Representatives: A. H. Noyes, B. S. McConnell, W. H. Blythe, F. W. Maechler.

Ballow Safety Rail Joint Co., Roanoke, Va.—Space No. 192. Exhibit: Non-frictional insulated rail joint; elongated nuts applied to the common bolt on ordinary rail joint, using a plain splice bar; frog equipped with the elongated nut; section of railway crossing using elongated nuts on standard bolts, in full size, 85 and 100-lb. steel rail; an insulated joint and bolts and a plain joint and bolts that have stood service. Representatives: C. E. Ballou, H. B. Rockhill.

The Barrett Co., New York City. Space Nos. 107, 108. Exhibit: Roofing (Barrett specification roofs), tar-rok sub-floor construction for wooden floors in machine shops, mill buildings and freight houses; bridge waterproofing, waterproofing and damp-proofing for masonry, wood preservatives, plastic cement, metal paints for cars and buildings and locomotives. Representatives: E. H. Poetter, W. S. Babcock, E. J. Caldwell, H. B. Nicholas, J. J. Ross.

Bausch & Lomb Optical Co., Chicago, Ill.—Space No. 47. Exhibit: Engineering instruments. Representatives: B. H. Witherspoon, C. A. Bengston.

Boss Nut Co., Chicago, Ill.—Space No. 13. Exhibit: Boss lock nuts. Representatives: J. A. MacLean, W. G. Willcoxson, M. C. Beymer, J. W. Fogg.

L. S. Brach Supply Co., Newark, N. J.—Space No. 2. Exhibit: Lightning arresters, automatic flagman, crossing bells, signal accessories. Representatives: A. G. Brach, Geo. Gaunt, Godfrey Gort.

Bryant Zinc Co., Chicago, Ill.—Space Nos. 153, 154, 155, 156. Exhibit: Highway crossing material; relays; batteries; battery supplies; bells; signal supplies. Representatives: Stanley C. Bryant, Harry F. Worden, Jerry Costigan, Otto S. Flath.

The Buda Co., Chicago, Ill.—Space Nos. 86, 87, 88, 89. Exhibit: Buda gasoline section motor cars, Buda gasoline motor velocipedes, Buda gasoline inspection cars, Buda electric storage battery trucks, Buda-Wilson (new type) bonding drill, Buda "Hyduty" Paulus track drill, Buda car replacers, Buda bumping posts, Buda ball-bearing and cone-bearing "Postop" jacks, Buda ratchet jacks, Buda "Hyduty" tool grinders, Buda ground throw switch stands, Buda electric crossing gates. Representatives: J. L. Artmaier, H. C. Beebe, C. H. Bull, W. C. Dyer, J. J. Gard, G. A. Glasford, W. F. Hebard, R. C. Horton, E. Johnson, W. Krause, N. C. Study, T. H. Wheeler, E. J. Porter.

Carbic Manufacturing Co., Duluth, Minn.—Space No. 169. Exhibit: Flare lights, and welding and cutting equipment. Representative: Gordon Paterson.

Carnegie Steel Co., Pittsburgh, Pa.—Space Nos. 52, 53, 71, 72. Exhibit: Steel cross ties, new; also ties after eleven years' service; "Braddock" insulated joints; "Duquesne" rail joints; reinforced angle bars; steel sheet piling; locomotive piston; rolled steel automobile flywheels; automatic stereopticon, showing views of installation of material. Representatives from general offices, Pittsburgh, Pa., and from Chicago sales office.

Chicago Bridge and Iron Works, Chicago, Ill.—Space Nos. 65, 66. Exhibit: Models of steel water tanks; enlarged photographs. Representatives: G. T. Horton, Merle J. Trees, Robert H. Murray, Horace B. Horton, Hiram T. Horton, C. S. Pillsbury, C. M. Ladd, F. L. Cook, H. J. Trum, E. G. Ladd, K. I. Small, R. Green, H. C. Brown, J. L. Zeller, H. B. Murphey.

Chicago Flag and Decorating Co., Chicago, Ill.—Space No. 189. Exhibit: Railway signal flags, manufacture demonstrated. Representatives: Geo. L. Glendon, L. G. Magnussen.

Chicago Malleable Castings Co., Chicago, Ill.—Space No. 180. Exhibit: The Thomas rail anchor tie plate, the Thomas guard rail. Representatives: Fred F. Bennett, Wm. H. Kofmehl, John W. Thomas.

Chicago Pneumatic Tool Co., Chicago, Ill.—Space Nos. 115, 116. Exhibit: Giant fuel oil engine class AO, size 9 x 8 in.; single tandem fuel oil-driven compressor, class N SO, size 9 x 8 in.; rock drills, consisting of type A 66, B 66 and C 66 Hummer drills, pneumatic tools; electric tools; speed recorder. Representatives: J. R. McFarland, J. W. Lowell, A. E. Swanson, C. E. Walker, J. F. Canby, J. C. Campbell, C. B. Coates, Ed. Aplin.

Chicago Railway Signal and Supply Co., Chicago, Ill.—Space Nos. 96, 97, 98. Exhibit: Mechanical signals and signaling devices; electrical signals and acces-

sories, relays, annunciators, indicators, highway crossing alarms and signal maintenance accessories. Representatives: C. N. Suhr, W. C. Martin, P. P. Williams, E. W. Vogel, W. M. McClintock, H. C. McNeil, F. L. Rainbow, Arthur C. Dunne.

Cleveland Frog & Crossing Co., Cleveland, O.—Space No. 91. Exhibit: Frogs, crossings, switches, switch stands. Representatives: G. C. Lucas, Geo. Stanton, L. G. Parker.

Clyde Iron Works, Chicago, Ill.—Space No. 182. Exhibit: One 8¼ x 10 double-cylinder double-drum four independent winch-head special railroad erector's engine, adapted to work on double track main line right of way. Representatives: E. S. Quinn, G. P. Miller, J. H. Crawford.

Commercial Acetylene Railway Light & Signal Co., Inc., New York City—Space Nos. 135, 136. Exhibit: Commercial acetylene and Aga flash light as applied to railroad signals, commercial acetylene as applied to locomotive headlights, commercial acetylene for oxy-acetylene welding and cutting. Representatives: C. E. Lee, O. F. Ostby, E. T. Sawyer, H. G. Doran, C. A. McCune.

Concrete Mixing and Placing Co., Chicago, Ill.—Space No. 172. Exhibit: Pneumatic concrete mixer and conveyor for tunnel lining work. Representatives: H. B. Kirkland, Edward Wray.

Cornell Wood Products Co., Chicago, Ill.—Space No. 164½. Exhibit: Cornell-wood-board. Representatives: C. O. Frisbie, E. W. Cowell, C. W. Litsey, P. A. Short.

The Creepcheck Co., Inc., New York City—Space No. 193. Exhibit: Anti-creeping devices. Representatives: A. Dinklage, O. Metcalf, M. A. Sheehan, C. Genscher.

Crerar, Adams & Co., Chicago, Ill.—Space No. 28. Exhibit: Jacks, drills, carbic lights. Representatives: J. A. Marbin, W. I. Clock, G. D. Bassett, C. W. Gregory, R. M. Bullard.

Daniels Safety Device Co., Chicago, Ill.—Space No. 149. Exhibit: Bulldog nut, bullpup nut, automatic tapping machine, boltless rail joint. Representatives: T. M. Daniels, W. D. Collins, W. E. Killen, C. C. Wood, Jr., M. Somsel.

Detroit Graphite Co., Detroit, Mich.—Space No. 106. Exhibit: Paints for bridges, buildings, water tanks, Sta-White for interior use, Anti-Aqua for damp-proofing. Representatives: Tom R. Wyles, L. D. Mitchell, J. J. Hogan, A. H. Kuerst, W. D. Waugh, E. Randolph, G. H. Varney, E. Booth, DeWitt C. Smith.

Paul Dickinson, Inc., Chicago, Ill.—Space No. 101. Exhibit: Smoke jacks, ventilators, chimneys, cast iron buildings. Representatives: J. A. Meaden, A. J. Filkins, W. A. Dayton, F. C. Webb.

Dilworth, Porter & Co., Ltd., Pittsburgh, Pa.—Space No. 27. Exhibit: Railroad spikes and tie plates. Representatives: C. Stein, W. F. Schleiter, Joseph Dilworth.

Joseph Dixon Crucible Co., Jersey City, N. J.—Space No. 117. Exhibit: Dixon's Silica-Graphite paint, boiler graphite, lubricating graphite, graphite greases, pipe joint compound, solid belt dressings, graphite brushes. Representatives: H. W. Chase, R. R. Belleville, J. E. Simpson.

The Duff Mfg. Co., Pittsburgh, Pa.—Space No. 167. Exhibit: Barrett track jacks, Duff ball-bearing screw jacks, Duff-Bethlehem hydraulic jacks. Representatives: E. A. Johnson, C. N. Thulin, C. A. Methfessel.

D. & A. Post Mold Co., Three Rivers, Mich.—Space No. 168. Exhibit: "D. & A." cement fence post machines; specimen posts; steel reinforcements; spacers; tie wire fence fasteners. Representatives: G. H. Dougherty, O. Dougherty, L. A. Dougherty, L. W. Dougherty.

Thomas A. Edison, Inc., Bloomfield, N. J.—Space Nos. 20, 21. Exhibit: Signal cells, demonstration board for track circuit work, automatic signal operated and lighted by Edison batteries. Representatives: E. E. Hudson, F. J. Lepreau, P. A. Garrity, E. W. Brown, P. B. Hyde.

Edison Storage Battery Co., Orange, N. J.—Space Nos. 21½, 22. Exhibit: Edison storage batteries. Representatives: H. G. Thompson, F. V. McGinness, H. M. Roberts, W. F. Bauer, C. A. Luckey, H. J. Butler.

The Electric Railway Improvement Co., Cleveland O.—Space No. 221. Exhibit: Rail bonds and equipment for their installation. Representative: G. Howatt.

The Electric Storage Battery Co., Philadelphia, Pa.—Space No. 1. Exhibit: Storage batteries. Representatives: G. H. Atkin, G. H. Groce, W. Borroughs, H. M. Beels, T. Milton.

Empire Railway Appliances Corporation, New York City—Space No. 27. Exhibit: Tieplate anti-creeper. Representatives: E. B. Powers, D. L. Braine.

The Eymon Continuous Crossing Co., Marion, O.—Space No. 169½. Exhibit: The Eymon continuous crossing. Representatives: Byron E. Wilson, Edward P. Dorward, A. W. Nyquist, J. H. Eymon.

Fairbanks, Morse & Co., Chicago, Ill.— Space Nos. 73, 74, 75, 76, 92, 93, 94, 95. Exhibit: 15 h. p. semi-Diesel engine, direct connected to a 10 k. w. generator in operation, 3½ h. p. motor, direct connected to 2½ in. centrifugal pump in operation, 7x10 power pump, 12x7x12 steam pump, deep well power head, locomotive water crane, electric motors, ball bearing and internal starter types, scales, motor cars. Representatives: Geo. J. Akers, K. P. Brown, F. M. Condit, F. P. Drinker, E. A. Elder, E. C. Golladay, C. T. Fugitt, D. J. Higgins, G. Howard, J. G. Jones, J. L. Jones, T. C. Kennedy, D. K. Lee, L. H. Matthews, C. W. Pank, E. E. Pendray, F. V. Roy, A. A. Taylor, H. E. Vergosen, F. N. Whitesell, C. H. Wilson.

Fairmont Gas Engine and Railway Motor Car Co., Fairmont, Minn.—Space Nos. 125, 144. Exhibit: Motor car mowing machines; motor car disc weeding machines; featherweight auto speeder; 8 h. p. heavy duty motor car engine with cone clutch for chain drive; 4 h. p. hand car engine. Representatives: H. E. Wade, W. F. Kasper, R. I. Sawyer.

Federal Signal Co., Albany, N. Y.—Space Nos. 36, 37, 55, 56. Exhibit: Alternating and direct current interlocking appliances, low volt switch machine, low volt signals, A. C. light signals, A. C. semaphore signals, A. C. relays, A. C. transformers, D. C. relays, interlocking relays, highway crossing signals, electro-mechanical interlocker, clock-work time releases, switch guard, bridge circuit controllers, battery charging switches, impedance bonds, electric locks. Representatives: A. H. Renshaw, John T. Cade, Carl Henze, W. H. Reichard, J. W. Hackett, H. G. Thompson, Paul Renshaw, J. J. Hubbard, H. P. Ober, J. W. Kelly, H. C. Ware, C. N. Beckner, S. J. Turreff, Casper Herringer.

The Frictionless Rail, Boston, Mass.—Space Nos. 133, 134. Exhibit: Frictionless rail. Representatives: F. A. Barbey, S. W. Simonds, G. H. Bryant, T. F. Dwyer, Jr.

The Fibre Conduit Co., Chicago, Ill.—Space No. 159. Exhibit: Fibre conduit for underground cables, fibre conduit and fittings for signal trunking, fibre conduit

and fittings for roundhouse wiring. Representatives: W. W. Smythe, Jr., F. C. Smith, D. E. Crum.

General Electric Co., Schenectady, N. Y.—Space Nos. 150, 151. Exhibit: Penn Dell automatic sub-station for maintaining power on a transmission line or service for two or more sources of electric supply, standard section type switch board for train lighting, baggage-truck and general battery charging, vacuum tube lightning arresters, enameled resistance units, indoor and outdoor type air-cooled transformers for low-voltage signal lighting, portable testing instruments. Representatives: W. O. Kellogg, W. J. Clark, W. H. Sigourney, C. C. Bailey, H. M. Jacobs, J. Roberts, B. F. Bilsland, S. W. McCune, L. W. Shugg.

General Railway Signal Co., Rochester, N. Y.—Space Nos. 38, 39, 40, 57, 58, 59. Exhibit: Electric Interlocking (dynamic indication): 16-lever model 2, unit-lever-type electric interlocking machine equipped with rotary circuit controllers, lever lights, lever locks and mechanical time release; operating switchboard; two-arm model 2A 110-volt non-automatic top-of-mast signal; model 2A 110-volt semi-automatic signal; 110-volt model 5 switch machine; relays and indicators; Mechanical Interlocking: adjustable deflecting bar, self-cleaning switch adjustment, low-voltage power signals, relays and indicators, model 2B electric lock and switch circuit controllers; electro-Mechanical Interlocking: eight-lever, model 2B electro-mechanical interlocking machine with rotary circuit controllers; Direct Current Automatic Block Signaling: 10-volt model 2A top-of-mast signal, 10-volt model 2A base-of-mast signal, three position motor relay, track and line relays, "copper-cup" ground plate, model 1B lightning arrester, model 1A adjustable resistance units, R. S. A. terminals, "Plagraphite" relay contacts; Alternating Current Block Signaling: model 2A base-of-mast signal equipped with 110-volt 60-cycle induction motor, light signals, line and secondary transformers, track and line relays, stub pole equipped with line transformer, plug cut-outs, lightning arresters and connections, resistance and impedance units; Selective Signaling System: Selector equipment, including selectors, bells, call keys, relays and silencer, R. S. A. "Take Siding" signal actuated by 10-volt model 2A signal mechanism; miniature track for demonstration of the "OS" arrangement, and an answer-back selector; model 5 low-voltage switch machine (for operation of outlying switches) operating in connection with a two-arm 10-volt model 2A signal and controlled by hand switch and indicator group; colored photographic enlargements showing views of several steam and electric railway signaling installations; electrical devices connected to energy and may be operated as under service conditions. Representatives: A. T. Carter, W. W. Coleman, S. M. Day, C. M. Deardorff, L. E. Dodge, F. L. Dodgson, M. F. Geer, W. S. Henry, W. K. Howe, S. Johnson, F. H. Jones, R. F. Kelly, H. W. Lucia, F. W. Moffett, G. D. Morgan, C. O. Poor, F. W. Rizer, F. B. Rosencrans, O. A. Ross, W. W. Salmon, V. I. Smart, H. M. Sperry, J. E. Stephenson, H. B. Taylor, L. Thomas, J. W. White, S. N. Wight, J. R. Willis, W. P. Woodruff, M. Wuerpel, W. R. Young.

W. & L. E. Gurley, Troy, N. Y.—Space No. 137. Exhibit: Engineering and surveying instruments, Gurley railroad transits with one piece truss standard and other improved features, transits, levels, leveling rods, stadia rods, compasses, current meters, sketching cases, tapes, etc. Representatives: H. M. Dibert, L. C. Higbee.

Hall Switch and Signal Co., New York City—Space Nos. 77, 78, 79, 80. Exhibit: Electric interlocking, automatic signals and equipment, highway crossing signals, telephone and telegraph selectors and equipment. Representatives: W. J. Gillingham, H. W. Wolff, O. B. Frink, H. L. Hollister, M. H. Beekman, R. Connell, J. A. Ritter, D. R. Day, B. A. Hinman.

The Hatfield Rail Joint Mfg. Co., Macon, Ga.—Space No. 166. Exhibit: Hatfield rail joints and crossing fastenings: Representatives: T. B. Bowman, M. R. Hatfield, Walter T. Johnson, C. P. Williams.

Hayes Track Appliance Co., Richmond, Va.—Space Nos. 140, 141. Exhibit: Hayes Derails: Model C, size 5, right with operating stand; Model E, size 5, right with target stand; Model EX, size 5, with repair track target stand; Model HXP, size 5, with lever; Model H, size 5, right with lever. Representatives: Stanley W. Hayes, W. Harding Davis, E. L. Ruby, E. W. Brown, R. W. Slautterback.

Hazard Manufacturing Co., Wilkes-Barre, Pa.—Space No. 3. Exhibit: Rubber-covered signal wire. Representatives: A. W. Gabriel, E. L. Willson, Thomas Keffe, L. W. Allen, George P. Cady, H. G. Gabriel, C. B. Semple.

Hoeschen Mfg. Co., Omaha, Neb.—Space No. 183. Exhibit: Hoeschen batteryless crossing signals, Hoeschen style "M" selective magneto generator, Hoeschen batteryless train drop annunciators. Representatives: F. K. Davis, R. A. Fry.

Hubbard & Co., Pittsburgh, Pa.—Space Nos. 142, 143. Exhibit: Track tools; claw bars, wrenches, mauls, shovels, scoops, etc. Representatives: Joseph V. Smith, O. W. Youngquist, G. H. McCammon, A. H. Handlan, Jr.

The Indianapolis Switch & Frog Co., Springfield, O.—Space Nos. 49, 50. Exhibit: Manganese frogs, switches, mates, crossings, switch points, unit drilled built-up construction, portable electric welders, electric welded joints; special trolley device for operating electric welders, grinders, track drills and cluster lights, allowing electric cars to pass without removing from trolley wire. Representatives: J. C. Jameson, E. C. Price, H. E. Freeman, W. H. Thomas, J. A. Foulks.

Ingersoll-Rand Co., New York City—Space Nos. 207, 208, 209, 210. Exhibit: "Imperial" pneumatic tie tampers, "Imperial" portable air compressor cars, a complete line of "Little David" pneumatic tools suitable for track work. Representatives: W. H. Armstrong, D. H. Seeley, Chas. Dougherty.

International Steel Tie Co., Cleveland, O.—Space Nos. 198, 199. Exhibit: Full size section of steel crossing foundation with crossing section in place on it, steel twin ties for paved street track. Representatives: Wm. P. Day, J. J. O'Donnell, W. C. Mahon, L. C. Shank.

Jaeger Machine Co., Columbus, Ohio.—Space No. 172½.

H. W. Johns-Manville Co., New York City—Space Nos. 174, 175, 176, 177. Exhibit: Asbestos and magnesia railroad supplies, smoke jacks, asbestos roofings, corrugated asbestos roofing, transite asbestos shingles, rubber type roofings, high and low pressure pipe coverings, sheet, ring, spiral, coil and rope packings for high and low pressure work, J-M steam traps, J-M fire extinguishers, lighting fixtures, NoArk enclosed fuse devices, electrical materials, underground fibre conduit for electric wiring, underground conduit for steam pipes, boiler laggings, tapes for all services, high temperature and insulating cements. Representatives: J. E. Meek, J. C. Younglove, G. A. Nicol, P. C. Jacobs, F. X. Connolly, F. J. Horne, H. B. Sewell, Geo. Christenton, D. L. Jennings, E. T. Wade, F. W. Doty, H. L. Leach,

H. A. Waldron, C. D. Folsom, J. H. Trent, E. H. Willard, R. A. Hamaker, H. T. Morris, L. E. Hassman, C. E. Murphy, W. J. Hennessy, H. G. Newman.

The O. F. Jordan Co., Chicago, Ill.—Space No. 222. Exhibit: Model of railroad spreader, pictures, etc. Representatives: Walter J. Riley, J. P. McNally, C. A. Levey, Wm. J. Tangerman, R. E. Bressler.

The Joyce-Cridland Co., Dayton, O.—Space No. 29. Exhibit: Lifting jacks for railway service. Representatives: G. W. Llewellyn, W. I. Clock, C. D. Derby.

Julian-Beggs Signal Co., Terre Haute, Ind.—Space No. 163, 164. Exhibit: Railway train control and speed control: Representatives: Steven Smith, Thomas E. Clark, M. H. Hovey, B. K. Read.

Kalamazoo Railway Supply Co., Kalamazoo, Mich.—Space Nos. 23, 24, 25. Exhibit: Hand, push and velocipede cars, motor cars, track drills, track jacks, track levels and gauges, drill bit grinders, cattle guards, etc. Representatives: J. McKinnon, D. A. Stewart, W. N. Sidnam, H. R. Miller, F. E. McAllister, W. C. Irwin, M. Babcock, H. N. Whipple, W. Winterle, H. Bosma.

Kellogg Switchboard and Supply Co., Chicago, Ill.—Space No. 184. Exhibit: Train dispatching telephone apparatus, selective signaling equipment, "Head in" signals for electric and steam roads, telephone apparatus in general. Representatives: W. O. Collins, A. J. Porter, E. A. Woodward.

Kelly-Derby Co., Chicago, Ill.—Space No. 11. Exhibit: Latest styles of two and four wheel all steel warehouse trucks. Representatives: C. W. Kelly, W. B. Holcomb, J. E. Angell.

Keppler Gas Constructions, Inc., 101 Park Avenue, New York City—Space No. 228. Exhibit: Keppler skylight construction for train sheds, stations, roundhouses, etc. Representatives: F. L. Keppler, M. H. Foley.

The Kerite Insulated Wire and Cable Co., New York City—Space Nos. 44, 63. Exhibit: Wire and cables. Representatives: Azel Ames, P. W. Miller, J. W. Young, J. A. Renton, B. L. Winchell, Jr., G. A. Graber, W. H. Fenley, J. A. Hamilton.

Keuffel & Esser Co., New York City—Space No. 168½. Exhibit: Drawing materials, surveying instruments, measuring tapes. Representatives: H. Huster, J. Lamb, E. Veasey.

Keystone Grinder and Manufacturing Co., Pittsburgh, Pa.—Space No. 194. Exhibit: Keystone hand and foot power railroad tool grinders. Representatives: H. C. Holloway, D. L. Braine, James C. Barr, W. Harding Davis, James C. Dolan, Georgia Supply Co., J. C. Kirby, Frank D. Nauman.

The Kilbourne and Jacobs Mfg. Co., Columbus, Ohio.—Space No. 190. Exhibit: K & J all-steel automatic air dump cars. Representative: David Green.

Lackawanna Steel Co., Lackawanna, Pa.—Space Nos. 31, 32, 33, 34. Exhibit: Standard and special shapes rail and angle bar sections, joint plates, tie plates, steel sheet piling, spikes and bolts. Representatives: C. R. Robinson, E. Armstrong, F. E. Abbott, A. P. Van Schaick, C. H. Hobbs, J. N. Hench, A. H. Weston.

Lansing Company, Lansing Mich.—Space Nos. 213, 214. Exhibit: Lansing electric freight house tractor; Lansing electric freight house hoist; Lansing freight house trucks; Reynolds' freight house trucks. Representatives: H. W. Woodward, Stowell C. Stebbins, Fred Schultz, H. H. Ames, J. T. Birney, A. C. Buck.

The Lehon Co., Chicago, Ill.—Space No. 148. Exhibit: Roofing for buildings, car roofing, waterproof insulating and refrigerator papers, saturated burlaps, saturated cotton fabrics, asphalt shingles, canvas passenger and coach roofing, damp-tite paints. Representatives: Tom Lehon, D. B. Wright, J. W. Shoop, E. A. Magurn.

Louisiana Red Cypress Co., New Orleans, La.—Space Nos. 200, 215. Exhibit: Louisiana red cypress. Representatives: Frank N. Snell, C. A. Nesom, H. P. Altman.

The Lufkin Rule Co., Saginaw, Mich.—Space No. 121. Exhibit: Measuring tapes and rules of all descriptions. Representatives: Theodore Huss, S. B. McGee, F. G. Brown.

Lumber Mfrs. Agency, Centralia, Wash.—Space No. 220. Exhibit: Fir lumber. Representatives: J. J. Jennelle, Jr., D. H. Davis.

John Lundie, New York City—Space No. 161½. Exhibit: Lundie tie plates. Representatives: John Lundie, Wallace Bigelow.

MacRae's Blue Book Co., Chicago, Ill.—Space No. 9. Exhibit: MacRae's Blue Book, the Railway Supply Index Catalogue. Representatives: E. B. Cooke, T. H. MacRae, L. R. Rollins, Lloyd Simonson.

The Madden Co., Chicago, Ill.—Space No. 195. Exhibit: Madden track layer, Richter blue flag derail, Wagner switch point straightener, Blair tie spacer, Suggitt reversible side ballast plow, the Brown rail loader. Representatives: H. C. Holloway, Thomas D. Crowley, V. L. Walker.

C. F. Massey Co., Chicago, Ill.—Space Nos. 35, 54. Exhibit: Reinforced concrete watchmen's houses, shelter station, cattle pass pipe, whistle, mile and sign posts. Representatives: C. F. Massey, F. S. Peabody, R. J. Collins, A. Christ, Jr.; D. A. Hultgren, F. E. Richert, Chas. Gilman, R. A. McDonald.

Miller Train Control Corp., Danville, Ill.—Space No. 197. Exhibit: A full size Atlantic type boiler head with all instruments showing the application of the Miller train control to the engineer's air brake valve, also the attachment to the throttle, giving the size, position and application of the control as applied to locomotives; automatic signal, parts of the shoe and control; Westinghouse electric pumps and necessary apparatus to furnish air for the operation of the control and the engineer's air brake valve. Representatives: W. B. Murray, H. B. Miller, J. N. Garber, C. A. Crowell, J. R. McSherry.

Morden Frog and Crossing Works, Chicago, Ill.—Space Nos. 90, 109. Exhibit: Solid manganese rigid frog No. 9, manganese guard rail, standard 11-ft. guard rail with Morden adjustable clamp and adjustable end blocks; switch stand for facing point switch, operating switch and point lock; G. L. M. malleable yard switch stand; point lock attachment for high main line stand. Representatives: Arthur C. Smith, W. J. Morden, W. Homer Hartz, B. T. Gibbs.

Mudge & Co., Chicago, Ill.—Space Nos. 127, 128, 146, 147. Exhibit: Mudge motor cars, classes E-3 inspection, E-6 inspection, GS-1 section, GS-2 section, F-1 section, GQ-2 handcar equipment, Smith motor wheel applied to hand velocipede. Representatives: Burton W. Mudge, Robert D. Sinclair, George W. Bender, Sherman C. Amsden, Blake C. Howard, W. D. Jenkins, Royal D. Hawley, C. M. Mudge, C. P. Benning, Clive Hastings, F. A. Ingalls.

M. W. Supply Co., Philadelphia, Pa.—Space No. 138. Exhibit: Vaughan rail anchor, Vaughan track indicator. Representative: David L. Vaughan.

National Carbon Co., Cleveland, O.—Space No. 152. Exhibit: Primary signal and track batteries, Columbia

dry batteries, Columbia Multiple and Hot-Shot batteries, storage batteries, flashlight batteries, carbon brushes, arc light carbons, welding carbons, carbon telephone specialties, special forms in carbons of all kinds. Representatives: Chas. S. Pflasterer, W. H. Arkenburgh, E. L. Marshall, J. M. Spangler, Walter R. Pflasterer, C. W. Wilkins, L. W. Fischer.

National Concrete Machinery Co., Madison, Wis.—Space No. 227. Exhibit: The National power fence post machine, including concrete mixer having a capacity of a fence post per minute of running time, National sheet steel molds for line and corner fence posts, ring and whistle posts, mile posts, etc.; National woven steel wire reinforcements for various types of posts; photographs of plants in railway service, showing process of manufacture, method of handling posts, etc., and posts in right-of-way fences. Representatives: J. B. Evans, V. E. Rogers, W. G. Clark, E. A. Everett, W. M. McClintock, B. K. Read.

National Lead Co., New York City.—Space No. 188. Exhibit: Dutch Boy red lead-in-oil, Dutch Boy white lead, Dutch Boy linseed oil, solder. Representatives: Charles Barr Field, Professor A. H. Sabin.

The National Lock Washer Co., Newark, N. J.—Space Nos. 201, 202. Exhibit: Hipower nut locks, parallel plain spiral nut locks for railroad track joint bolts. Representatives: John B. Seymour, R. L. Cairncross, A. T. Thompson, J. T. Patterson, Jesse Hough.

The National Malleable Castings Co., Cleveland, Ohio. Space No. 105. Exhibit: Rail anchors, malleable rail braces, malleable tie plates, malleable spools and washers. Representatives: James A. Slater, T. W. Aishton, C. H. McCrea, J. J. Byers.

National Standard Co., Niles, Mich.—Space No. 185. Exhibit: Magic tool grinders with attachments, Cook's improved bonding drills, Climax track drills, standard jacks. Representatives: C. R. Wescott, R. L. Brown, F. A. Buckley, W. H. Parkin, W. F. Harrah, Guy Hayman.

Geo. P. Nichols & Bro., Chicago, Ill.—Space No. 173. Exhibit: Electric turntable tractors. Representatives: George P. Nichols, S. F. Nichols, Henry Fries, Nicholas Fries.

Northwestern Motor Co., Eau Claire, Wis.—Space No. 196. Exhibit: Railroad gasoline motor cars. Representatives: R. R. Rosholt, K. Rosholt.

Ogle Construction Co., Chicago, Ill.—Space Nos. 12, 31. Exhibit: Automatic coaling station. Representatives: M. W. Powell, R. A. Ogle, C. F. Bledsoe, L. S. Murphy.

The Okonite Co., New York City—Space Nos. 16, 17. Exhibit: Okonite insulated wires and cables of every description for every kind of electrical service, Candee potheads, Okonite and Manson tapes, etc. Representatives: Lewis G. Martin, J. D. Underhill, W. T. Kyle.

O'Malley Beare Valve Co., Chicago, Ill.—Space No. 114. Exhibit: Globe valves, angle, check, locomotive and blow-off valves. Representatives: Edward O'Malley, Thomas O'Malley, William Leighton, Blake C. Hooper, H. M. Newell.

Otley Paint Mfg. Co., Chicago, Ill.—Space No. 10. Exhibit: "Eureka Brand" railway locomotive paints, cements, specialties. Representatives: B. F. Otley, James J. Otley, Walter A. Otley.

W. W. Patterson Co., Pittsburgh, Pa.—Space No. 145. Exhibit: Tackle blocks—high grade, hand made, double extra heavy. Representative: W. W. Patterson, Jr.

The Pennsylvania Steel Co., Philadelphia, Pa.—Space No. 30. Exhibit: Frogs, switches, switch stands, etc. Representatives: R. W. Gillispie, G. S. Vickery, R. L. Gillispie, Stanley H. Smith, Fred H. Ogden, J. F. Hennessey, K. C. Banks.

The Peyton Safety Rail Joint Co., Centralia, Ill.—Space No. 226. Exhibit: Rail joint. Representative: Warren Perry.

Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.—Space No. 103. Exhibit: Steel tanks, stand pipes, coaling stations, sanding stations, pictures, plans and models. Representatives: W. W. Hendrik, A. C. Pearsall, H. J. Klurzing, J. E. O'Leary, C. L. Todd, G. A. Smith, W. H. Jackson.

Pocket List of Railroad Officials, New York City.—Space No. 26.

Positive Rail Anchor Co., Louisville, Ky.—Space Nos. 178, 179. Exhibit: Positive rail anchors, Betts tie plates, Economy guard rails, Economy switch points. Representatives: W. M. Mitchell, Frank M. Robbins, John C. Haswell, L. C. Ferguson, J. A. Shoulty, L. C. Ryan, A. H. Told, W. M. Mitchell, Jr.; W. A. Wallace, C. J. Webb, W. Harding Davis.

The Protective Signal Mfg. Co., Denver, Colo.—Space No. 158. Exhibit: Highway crossing signal complete, including wig wag bell, relays, track instruments, masts, relay box; type "C" oscillators: time relay units; alternating and direct current signal devices; automatic thermo time units, highway crossing bells. Representatives: D. R. Morris, W. C. Neahr, A. M. Adams.

Pyrene Mfg. Co., New York City—Space No. 186. Exhibit: Pyrene fire extinguisher, safety cans, oily waste cans, 2½-gal. soda and acid extinguisher, 40-gal. chemical tanks, fire hose, fire buckets, fire axes, water and sand. Representatives: J. D. Cole, R. G. Henderson, H. B. Boykin, E. L. Kent, G. C. Breidert, W. B. Paulson.

The P. & M. Co., Chicago, Ill.—Space Nos. 122, 123. Exhibit: P. & M. rail anti-creepers (or rail anchors), bond wire protectors. Representatives: F. A. Poor, P. W. Moore, F. A. Preston, A. R. Sutter, G. E. Johnson, D. T. Hallberg, R. W. J. Harris, H. G. Warr, F. N. Baylies, R. D. Hawley, A. B. Griggs, W. C. Lynch, L. S. Walker, R. J. Mercur, F. C. Webb, G. A. Macpherson, J. W. Dodge, R. H. Johnson, J. E. Mahoney, J. Ritchie, W. W. Glosser, J. Reagan, C. J. Duggan, P. V. Samuelson.

The Q. & C. Co., New York City—Space Nos. 120, 139. Exhibit: Bonzano rail joints, rolled steel step joints, insulated joints, guard rail clamps, guard rail bracers, Samson rail benders, portable rail saws (hand and power), derails (adjustable), Vaughan rail anchor, Peffers air brake hose protector, magnetic wig-wag crossing signal. Representatives: L. T. Burwell, H. A. Hawes, W. W. Hoit, A. R. Horn, F. F. Kister, E. R. Packer, G. T. Pool, C. F. Quincy, Edmund Quincy, A. Robertson, Edgar M. Smith, J. V. Wescott.

The Rail Joint Co., New York City.—Space Nos. 81, 82. Exhibit: Continuous, Weber, Wolhaupter and 100-Percent rail joints. Representatives: L. F. Braine, Percy Holbrook, Benjamin Wolhaupter, W. Paton Thomson, McLeod Thomson, G. C. Isbester, E. A. Condit, Jr.; R. W. Payne, J. G. Miller, E. L. Van Dresar, J. C. Barr, F. C. Webb, V. C. Armstrong.

The Railroad Supply Co., Chicago, Ill.—Space Nos. 85, 104. Exhibit: Chicago derailer, rolled steel tie plates, automatic flagman or wig-wag, electric highway crossing bells (gong and locomotive type), trolley contactors, interlocking relays for steam and trolley road

service, channel pins, resistance units and other signal accessories, battery and relay housings. Representatives: E. H. Bell, G. M. Kenyon, H. G. Van Nostrand, H. M. Buck, G. W. Nibbe, Geo. T. Cook, R. S. Prentice, F. C. Webb, J. M. Fitzgerald, A. H. Smith.

Railway Age Gazette, New York, N. Y.—Space No. 45. Exhibit: Railway Age-Gazette, Maintenance of Way Daily, Railway Signal Engineer, Railway Electrical Engineer, Railway Mechanical Engineer, The Signal Dictionary. Representatives: Edw. A. Simmons, Samuel O. Dunn, Lucius B. Sherman, Henry Lee, E. T. Howson, C. R. Mills, F. H. Thompson, H. H. Marsh, H. F. Lane, R. E. Thayer, H. H. Simmons, Frank S. Dinsmore, W. S. Lacher, J. M. Rutherford, G. L. Lacher, John N. Reynolds, A. F. Ashbacker, B. W. Matthews, John H. Cross, M. S. Foote, T. E. Crossman.

Railway Periodicals Co., Inc., New York City—Space No. 185½. Exhibit: Railway Engineering and Maintenance of Way, Railway Master Mechanic, The Monthly Official Railway List. Representatives: Ernest C. Brown, J. A. Kucera, C. S. Myers, J. W. Barbour, L. A. Horswell.

Railway Review, Chicago Ill.—Space No. 64. Exhibit: Railway Review. Representatives: Willard A. Smith, Harold A. Smith, W. M. Camp, Charles S. Bates, J. E. Gougeon.

Ramapo Iron Works, Hillburn, N. Y.—Space No. 110. Exhibit: Track work, automatic safety switch stands, manganese reinforced switch points, rolled shoulder switch riser plates, manganese insert frog, guard rail clamps, etc. Representatives: W. C. Kidd, Thomas E. Akers, J. Edgar Davidson, Arthur Gemunder, James B. Strong.

Reading Specialties Co., Reading, Pa.—Space Nos. 7, 8. Exhibit: Rail benders, car replacers, guard rail clamps, tie spacers, compromise joints. Representatives: J. Turner Moore, M. G. Moore, B. J. Buell, Henry G. Fennell, Daniel H. Fowler, A. S. Flowers, Atkinson & Uteck, the Herr-Rubincam Supply Co.

Roberts & Schaeffer Co., Chicago, Ill.—Space No. 48. Exhibit: "RandS" measuring loader for locomotive coal, Beamer patent steam sand dryer, photographs and diagrammatic drawings of standard counter-balanced bucket locomotive coaling plants and "RandS" gravity sand plants. Representatives: Clyde P. Ross, H. S. Shimizu, E. E. Barrett.

Sanitary Bunk Co., Indianapolis, Ind.—Space No. 205.

Sellers Mfg. Co., Chicago, Ill.—Space No. 124. Exhibit: Tie plates. Representatives: George M. Hogan, R. A. Van Houten.

Signal Accessories Co., New York City—Space No. 118. Exhibit: Triplelock switch machines, Bossert switch adjustments, SACO enameled steel signal blades, Welday adjustable rail braces, triplepath lighting arresters, black brand signal friction tape, P-L rounded protectors, Rapp foundation extensions, Ziegler relays, electric light automatic cut-in relays, resistance units, general signal accessories. Representative: F. C. Lavarack.

Simmen Automatic Railway Signal Co., Buffalo, N. Y.—Space Nos. 5, 6. Exhibit: Simmen dispatcher's table for controlling signals on moving trains and for recording the movement of trains in the dispatcher's office, model of the Simmen cab signal in operation. Representatives: P. J. Simmen, C. E. Chatfield, L. Ringer, G. P. Simmen, W. H. Crawford.

T. W. Snow Construction Co., Chicago, Ill.—Space No. 46. Exhibit: Water columns, oil columns, tank hoops, etc. Representatives: T. W. Snow, Barton Snow, W. A. Lathrop.

Southern Pine Association, New Orleans, La., Space Nos. 203, 204, 211, 212. Exhibit: Samples of pine illustrating new density rule; examples of service tests of creosoted piling; fence posts, bridge timbers, crossarms, etc.; samples of new creosoted material, track sections showing modern methods of using creosoted yellow pine for track purposes, including standards of the P. & L. E. and the D. L. & W.; samples illustrating improper uses of longleaf pine and pine, leading to failure; samples illustrating service tests with creosoted wood block paving for both outdoor and shop purposes; representatives, Arnold Von Schrenk, J. C. Valadie, Mr. Pendleton.

Willis C. Squire & Co., Chicago, Ill.—Space No. 160½. Exhibit: Stop and waste hydrants and hydrant valves; switch and water service thawing outfits; portable oil burners. Representatives: Willis C. Squire, E. P. Cogswell, G. A. Nelson.

Standard Asphalt and Rubber Co., Chicago, Ill.—Space Nos. 161, 162. Exhibit: Waterproofing, mineral rubber floors, insulation, roadways. Representatives: Robert F. Trumbull, R. E. Kartack.

Standard Underground Cable Co., Pittsburgh, Pa.; Space, No. 18; Exhibit, Wires and cables for electrical purposes and cable terminals; cable junction boxes, etc. Representatives:

Staple Post Mold Co., Westerville, O.—Space No. 160. Exhibit: Molds for the manufacture of concrete posts, accessories. Representatives: H. L. Pettit, R. B. Bennett.

Templeton, Kenly & Co., Ltd.—Space No. 113. Exhibit: Simplex jacks for cars and tracks; Simplex emergency jacks; Simplex pole jacks. Representatives: W. B. Templeton, J. H. Hummel, A. C. Mills.

The Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—Space No. 15. Exhibit: Ferro carbon-titanium, titanium aluminum bronze castings, bronze castings: Representatives: H. H. Cook, A. C. Hawley.

Track Specialties Co., New York City.—Space No. 206. Exhibit: "Superior" rail joints, "Superior" compromise joints, "Trasco" insulated joints, "Superior" derailer, "Trasco" guard rail clamp, "Trasco" guard rail brace, "Superior" padded tie plate, "Superior" rail benders. Representatives: W. B. Lee, John A. Bodkin, W. M. Osborn, R. L. Mason.

Tyler Underground Heating System, Pittsburgh, Pa.—Space No. 181. Exhibit: Section concrete tunnel piped for steam and hot water; section 1, pipe ditch construction for steam or hot water; section 2, pipe (steam and return) ditch construction for steam, anchors, expansion joints with bored guide and support for follower, wall brackets to hold one, two or three pipes, samples ditch casing one inch to twenty-four inches, samples tunnel and outdoor casing, condensation meters, steam traps. Representatives: E. B. Tyler, E. M. Hatheway, C. E. Stewart, J. W. Copeland, W. T. White.

The Union Switch & Signal Co., Swissvale, Pa. Space Nos. 41, 42, 43, 60, 61, 62. Exhibit: Interlocking Machines: type "F," model 14, electro-mechanical type "P-4," two-unit push-button machines;—Ground Signals, top post styles "T-2" A.C. three position, "T-2" D.C. 3 position upper quadrant signal, electro-pneumatic, three position, ground signals, style "B," A.C. 11-volt 60-cycle left-hand upper quadrant, traction type, style "S" D.C. with case, instruments and interior wir-

ing;—Position Light Signals: A.C. model 14, with instruments and internal wiring, dwarf with adjustable reflectors;—Switch and Lock Movements: electro-pneumatic, rack and pinion type, model 13-A, 110-volt D. C. with de-energized and point circuit controllers, model 13-A D.C. 20 volts, type "G" with post lock, electro-pneumatic direct acting, controlled from two-unit push-button machine;—Switch Circuit Controllers: Universal, two and three positions, and vertical rotary;—Circuit Controller, interlocked, 3-unit; Keystone insulated rail point; automatic regulator for alternating current track circuits; phase meter, for measuring phase angles on alternating current track circuits—Relays: model 12 A.C. polyphase track two position, model 12 A.C. polyphase track three position, radial polyphase A.C. track three position, model 16 A.C. line, model 15 A.C. three position vane type, model 16 vane type interlocking 4 front and 2 back contacts each side, A.C. standard vane track for steam roads, galvanometer A.C. track two position, model 16 brakeless centrifugal, model 12 D.C. polarized, model 13 D.C. four point, model 13 D.C. two point high voltage contacts, model 12 D.C. interlocking; 75 and 200 volt ampere track transformer, air-cooled, enclosed type—Impedance Coils: electric road type 600-volt amperes, steam road types 100 and 300-volt amperes—Adjustable Track Resistances; Electric Locks, model 12 A.C. and D.C.; Clock Work Time Release; Tower Indicators, A.C. "Z" armature semaphore type, A.C. "Z" armature disc type, model 11 D.C. with three front and two back contacts, model 11 D.C. with five front and four back contacts, model 11 D.C. with eight front and two back contacts—Forgings: railway signal appliances, automobile parts, aeroplanes, general forgings—Keystone insulated rail joint, model 14. Representatives: W. D. Uptegraff, T. W. Siemon, J. S. Hobson, C. E. Denney, G. A. Blackmore, W. H. Cadwallader, Aaron Dean, J. P. Coleman, H. W. Griffin, J. J. Cozzens, C. O. Harrington, H. R. Sheene, H. A. Wallace, R. P. Tuttle, L. F. Howard, J. E. Saunders, W. Zabel, W. W. Talbert, S. E. Gillespie, J. D. Roett, George Marloff, H. A. Hamilton, J. F. Talbert, J. L. Loucks, J. T. Mallanny, J. H. Deming.

U. S. Wind Engine and Pump Co., Batavia, Ill.—Space Nos. 111, 112. Exhibit: Curtis double acting pumps, deep well working barrel or cylinder, ground switch stands, low semaphore switch stands, foot latch for switch stand, model windmill pumping outfit, model of tank and tower outfit, model of 12 post railroad tank structure with tank and outlet fixtures, round, half-round and flat tank hoops, water column with telescopic spout, positive and hydraulic water column valves, samples of pine, fir and cypress tank lumber. Representatives: L. E. Wolcott, C. E. Ward, G. E. Vermilyer, J. P. Prindle, Jr., F. E. Pearson.

Verona Tool Works, Pittsburgh, Pa.—Space No. 129. Exhibit: Track tools, gauges, levels, jacks, nut locks, rail anchors. Representatives: H. S. Paul, H. Fischer, E. Woodings, H. C. Mull.

Wayne Oil Tank and Pump Co., Fort Wayne, Ind.—Space No. 171. Exhibit: Self-measuring oil pumps and tanks for storage in connection with railroads. Representatives: B. F. Geyer, J. B. Beall.

Western Electric Co., New York City—Space Nos. 4, 19. Exhibit: Complete train dispatching telephone equipment; typical samples of incandescent lamps and maintenance apparatus pertinent to telephone work, such as cross-arms, poles, glass insulators, etc. Representatives: G. H. Porter and G. K. Heyer.

Wm. Wharton, Jr., & Co., Inc., Easton, Pa.—Space Nos. 68, 69. Exhibit: Tisco manganese steel frog, of solid and insert designs, W-J switch stands, guard rail clamps, split switch with Tisco manganese steel tips and equipped with Wharton-O'Brien insulated lock and pulling rods, adjustable rail braces and several styles of regular braces, Wharton-O'Brien insulated pulling and lock rods for double slip switches. Representatives: Arthur S. Partridge, H. F. McDermott, S. G. Llewellyn, Robert C. McCloy, D. L. Swank.

Yale & Towne Mfg. Co., New York City—Space No. 157. Exhibit: Triplex hoists, railway padlocks, switch locks, signal box locks, cabinet locks, night latches, door closers, station hardware. Representatives: Wm. J. Nahrwald, W. C. Bigelow, J. H. Bricker, R. J. Kleinsmid, W. A. Lockwood.

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Architecture in Railroad Engineering Work

Development of Stations from Purely Utilitarian to Artistic and Convenient Public Building

Architecture in railroad work as here presented is not intended to be a discussion of ethics of architecture, nor of the merits of any one designer as compared with the merits of any other designer, but is intended to be more in the nature of a history of the development of architecture in railroad work and of the efforts of architects to design railroad buildings, for whatever use they were intended, that should be economical from a constructive point of view, having low maintenance expense as well as long life, and with all an artistic exterior, and interior as well, that is in keeping with the locality within which the building is placed and that is best adapted to serve the purpose for which it is intended.

These were the opening remarks of Mr. F. M. Davidson, architect of the Boston & Albany, at a recent meeting of the New England Railroad Club. We are able to present a brief review, as follows. He said among other things:

"There are records in the B. & A. files which show that architectural services were rendered as far back as 1840, but apparently this was only in the design of an occasional station. It may be noted here that the development of architecture in this direction has been coincident with the development of the railroad. When the first railroad was completed from Boston to Worcester the prime object of the road was traffic, and the stations were modest wooden affiairs of relatively cheap construction; but as business grew and the importance of the railroad increased the necessity for increased facilities for handling the business became apparent and the services of the architect were sought with ever increasing frequency. But even then the stations were as a rule built of wood, with now and then one of brick.

"Some old stations now in use as freight houses, for instance, Auburndale, was built in 1850, West Newton in 1850, East Brookfield and West Brookfield somewhere between 1841 and 1846, Rochdale 1838, West Brimfield probably in the early 'forties' and Brighton at a later date, 1858. Cottage Farms was built so long ago that nobody remembers. In 1864 a new station at Foster St., Albany, for joint occupation was built by the Boston & Worcester, the Norwich & Worcester and the Worcester & Nassau. Later a new station was built, a part of which is now standing. When this station was erected, it was considered from an architectural point of view as one of the show stations of the country. The lines of the tower were so good that it became a land mark. The railroad, owing to the wishes of the citizens of Boston kept a portion of the head house and the tower, when the new station was built.

At this time many railroad stations were built of which there had been no plans, but only a rough sketch. As an example one may mention the case where a rough sketch made by a foreman carpenter to show to the general superintendent, was all there was. Now every railroad has its standard stations, freight houses, engine houses, and other buildings are to-day built from standard plans. Up to fifteen years ago no buildings except stations on the B. & A. were designed by architects, and these were commissions given to regular practising architects, who designed the station and supervised the construction.

Owing to the advent of the important work of grade crossing elimination at important points, and the development of facilities on the water-front, involving the alteration of large and expensive buildings and the construction of many new buildings it was decided to try the experiment of having an architect on the pay-roll of the construction department, and the speaker was engaged in February, 1901, as the experiment, being told at the time that it was an experiment and might be good for one week or for life. Since 1901 practically every building erected on this railroad has been designed and the construction supervised by the railroad forces. As to the success or failure of the experiment it can only be said: that it has been demonstrated time and time again that the road is saving money, that is in salaries as compared with architects commissions.

There is no man in the profession who has a greater variety of structures to deal with than the railroad architect, and the number of complex situations having to be met is multitudinous. Railroad men know that the architect has to please the president, the vice-president, the general superintendent, the general manager, probably the chief engineer, and the signal engineer and all the other officers of the road as well as the public.

Railroad buildings should be economical from a constructive point of view, having low maintenance expense, etc. The principle that the best is the cheapest in the long run, and also that cheapness is not necessarily economy, is the view taken. Of course, a flagman's shanty on a cross road out a hundred miles in the woods, may be cheap and probably unattractive, but a building for the accommodation of the American Express Company on a principal street in Worcester, Mass., must be as nearly fireproof as possible and in keeping with the other buildings in the vicinity, and as expensive as the conditions warrant.

The majority of the B. & A. buildings were made to be fire resisting as far as possible, at least on the exterior. Reinforced concrete is a predominant part of station buildings and on Mr. Davidson's road he reported it to be as satisfactory a structuray material as any. The company, however, built an interlocking signal tower of concrete, but discontinued the subsequent use of this material, as the problem of building extension did not seem to be solved by the use of a monolithic structure. Brick was found to be better suited to requirements of the case.

Great improvements have been made in the matter of heating, lighting and ventilation of buildings. The old style hot air furnace, like the car stove, has practically disappeared. If used at all, the registers are placed at such a height as to be above a man's head, in the walls of the building. Steam for heating and electricity for lighting are installed in their latest forms wherever it can be done.

In the discussion that followed, Mr. Murphy pointed out that architectural development has kept pace with that in the other lines of railroad work. It is very interesting to study the gradual progress from the purely theoretical design of a station apparent in the first buildings after the 1840 crop, which were the first designed by architects. These were evidently built after an architect drew a perspective and then fitted the interior to it. If the station was dark, the architecture was good; if the plumbing was not very good, the building looked well from the outside; if the heating was not very good, it could be remedied later. As things kept growing, the architect began to realize more and more that the object of the station was to please the public, not only as to outward appearance, but also as to convenience. The use of more elaborate heating systems and electricity brought in new problems, and the mechanical engineer became a very great help and an important factor in the design and construction of stations. We have now come to the point where a station is designed by planning the facilities first and drawing the perspective later. The result has been very good. We have stations that have plenty of natural light, that are well ventilated, that are well illuminated, that are well heated, and that are so built that the maintenance costs have come down considerably.

It might be well to say a word about the low platform arrangement. On the New York Central some high platforms are used, but the question has been carefully studied and the lifting of baggage to the high level platform has been considered. Platforms are now made on this road, one foot above the tie, and the distance from the center track to the edge of the platform has been so determined that while the platform does not encroach on the largest coaches, it is near enough to the steps of a car not to endanger a woman or even a child falling between car and platform when stepping aboard.

Following, Mr. Pearson said it is a difficult matter for any architect to design a station that will suit everybody. In one station the large arch was designed by Mr. Richardson, designer of Trinity Church, who was considered one of the foremost architects of this country. Another station was designed by Bradford L. Gilbert, who was considered a very fine architect. To design a station that will accommodate every one, so that you can get your baggage checked, buy your ticket, catch your train in three minutes is almost impossible. One of the recent stations that we constructed was by request of the local people designed to accommodate them and to carry out their wishes. The result was it was built between two public streets, with a granolithic sidewalk 900 ft. long connecting the two streets, and the principal features they insisted on and that afterwards proved to be of great help, were, first, that the toilet rooms should be handy to one entrance and the drinking fountain should be handy to the exit, the idea being that people would go in one door, use all the facilities and pass on.

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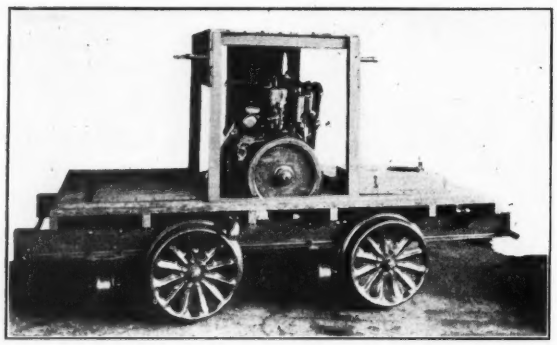
H. S. Norris has recently been engaged by the C. A. Willey Co., Long Island City, N. Y., as manager of railway sales. He will have charge of their line of railway paint specialties. His resignation from the U. S. Metal & Manufacturing Co., New York, takes effect Feb. 15.

The National Indicator Co., 852 Vernon avenue, Long Island City, N. Y., whose factory was recently destroyed by fire and whose models, in preparation for the National Railway Appliance Association convention, were destroyed at that time, reports that very satisfactory progress is being made in rebuilding their factory. More light and better manufacturing facilities will be a great advantage in making their specialties. A new apparatus is being installed for applying a rustproof coating to all machines. It is expected that the plant will be in operation by April 1st.

New Methods and Appliances

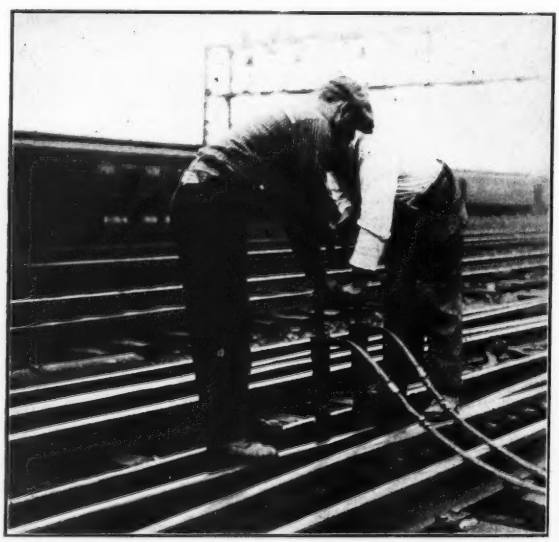
Pneumatic Tie Tampering Machine

The Ingersoll-Rand Co., 11 Broadway, New York, have recently placed on the market the "Imperial" pneumatic tamping machine which has proven the means of materially reducing the cost of track ballasting and maintenance. The replacement of hand labor with machines has become the fixed policy of nearly every up-to-date railway company. In the coming season, with the abnormal shortage of unskilled labor, due to present conditions, this will be brought out more strongly than ever.



"Imperial" Compressor Mounted on Section Car

These tampers are operated in pairs, one on each side of the tie as shown in the first illustration. The operation of the tool is a rapid hammer action on the tamping bar which in turn compacts the ballast and forces it down and under the tie. It is the practice to tamp each tie a distance of about 16 to 18 ins. either side of the rail. Observations made on a railroad where new track was being raised from 2 to 3 ins. on stone ballast, showed an average of 240 ties tamped per nine-hour day, at a total cost of 2 cents per tie. One of the particular advantages in the use of pneumatic tampers is the ease with which they operate in cramped quarters such as switches, frogs and crossovers. These are all places where hand tamping, to be well done, is a very difficult and in some cases a practically impossible task.



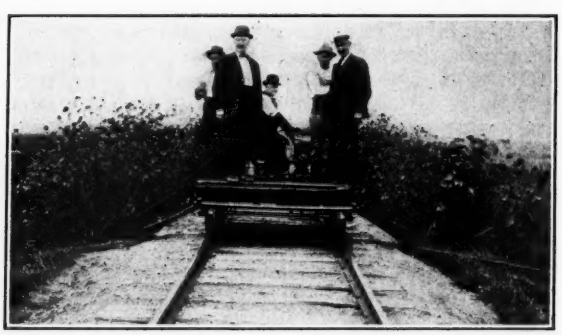
Operating "Imperial" Pneumatic Tie-Tamper in Close Quarters Around Switch

For operating these tie tampers the Ingersoll-Rand Co. builds a special "Imperial" compressor unit in two styles. The ordinary outfit used is the gasoline motor driven type. This consists of a handcar mounted vertical air compressor with reservoir cooling system direct conected to a gasoline motor. Suitable air receiver and piping are included. This compressor is designed to operate two tamping machines. A larger size capable of operating four tampers has recently been brought out. Both of these compressor cars are self-propelled and capable of transporting the section gang to and from their work.

An electric motor driven type is built for service where electric current is more convenient. The tamping machines are very economical in air consumption and it has been found practicable to operate them from switch and signal service air lines without interfering with the operation of signals, etc.

The manufacturers state that track tamped with "Imperial" tie tampers will be more evenly ballasted, that the ballast will be more finely packed and that the settlement of trackage will be much less and far more uniform than with hand tamping. The machines handle stone, cinder or other ballast with equal effectiveness.

Fairmont Gas Engine and Motor Car Co., Fairmont, Minn., have placed on the market a mowing machine, No. 24, for cutting weeds along the right of way. The illustration shows the machine cutting a heavy growth of Kansas sunflowers. The machine mows weeds and grass on both sides of the track at the same time, cutting a 6-ft. strip outside the weed line, at a rate of three miles per hour. Varying slope of the grade makes no difference. One man on each side of the machine operating two levers can easily raise or lower or vary



Fairmount Mowing Machine No. 24 Cutting South Dakota Sunflowers

the angles of the cutter-bars so that they will follow the ground perfectly, while the machine cuts right along without stopping. The bars can be very quickly raised to avoid obstructions. With the cutter bars raised the machine will travel 15 miles per hour in high gear. During portions of the year when there is no grass to cut the engine can be removed and installed on an ordinary section car. One of these cars will take care of the weed cutting on 500 miles of track.

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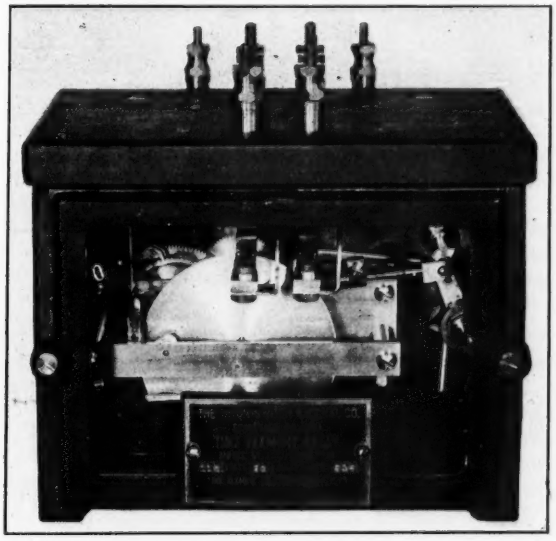
Time Element Relay

The Union Switch and Signal Co., Swissvale, Pa., have recently developed a time element relay which recognizes the importance of train speed as a factor in determining whether certain train movements may safely be made, and which makes the signal aspect dependent upon the speed of the approaching train as it enters the block governed by the signal, by measuring the time required to traverse the length of block. This idea has been proven highly advantageous as a means for safely facilitating traffic under certain conditions of traffic congestion.



Time Element Relay

This "time element" relay comprises an operating movement consisting of an induction motor type line relay of rugged construction, and a retarding device connected between the operating movement and the relay contacts, so constructed that a definite time interval is interposed between the time that the energy is applied to the relay and the time that the relay closes its front or opens its back contacts. This time element may be adjusted without opening the case to any value up to 30 seconds. The retarding device is so designed it is almost wholly immune to variation due to changes in external conditions, and operates in a uniform time irrespective of variation in the voltage or frequency applied to the relay.

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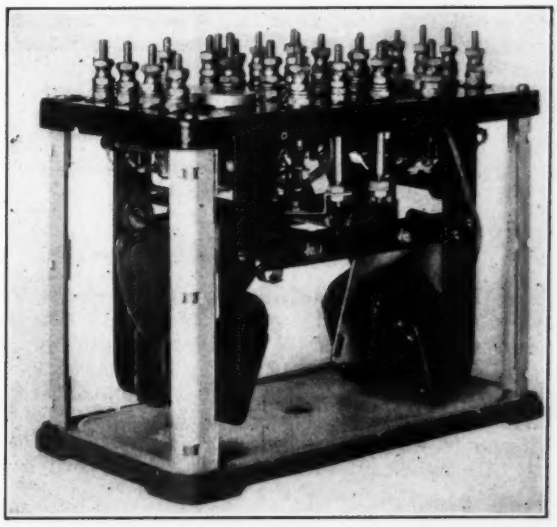
Vane Type Interlocking Relay

The Union Switch and Signal Co., Swissvale, Pa., has developed a new alternating current interlocking relay possessing many features, which give it a wide application. This relay embodies all the well-known operating characteristics of the Union Co.'s standard direct current interlocking relay, having substituted for the D. C. magnets the simple A. C. vane operating elements. In the case of simultaneous de-energization of both sides of the relay, both sets of back contacts cannot be held open on account of the special locking construction.



Mechanism of Vane Type Interlocking Relay

The new Model 16 Vane type interlocking relay is positive in the operation of the contacts and is free from any possibility of the locking arms being improperly released. The construction of the vane operating elements is essentially that of the standard Union single element vane relay, which does not respond to direct current. The vertical position of the air gap between pole faces and vane insures against the collection of dust or small foreign particles which might obstruct

Contacts of Vane Type Relay

the moving element. This relay is provided with a top plate of insulating material which carries the locking device, the two vane elements and the terminal posts. The terminal posts are non-turning and conform to R. S. A. requirements. Each side of the relay can be

provided with four front and two back graphite to graphite, metal to metal, or metal to graphite contacts, as required.

Either or both sides of this relay can be wound for operation on any of the usual frequencies and for any potential up to 220 volts. This makes it suitable for use on either electric or steam road track circuits or for control from line circuits. The coils are form-wound and especially insulated. They will withstand a ground test in excess of R. S. A. requirements.

In brief, this relay with its adaptability, simplicity of construction, unresponsiveness to direct current, and reliability of operation should produce a highly satisfactory alternating current interlocking relay.

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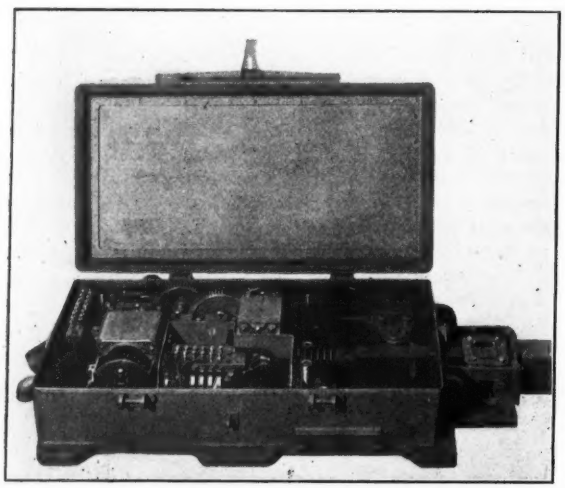
Low Voltage Switch Movements

The Union Switch and Signal Co., Swissvale, Pa., have presented a solution of the problem of properly protecting the switch at the entrance of a passing siding by some means other than by the use of hand-operated switches and electric locks. A hand-operated switch necessitates the stopping of the train so that the trainmen may open the switch. This stop, together with that incidental to the closing of the switch on leaving the siding, keeps the train on a given section several minutes longer than would be necessary if some



Low Voltage Switch Movement

means of power operation of the switch were provided, to say nothing of the resultant wear on apparatus and waste of coal. The installation of a high voltage D. C. switch movement is not to be considered on account of the cost of installing and maintaining the necessary storage battery.

These difficulties have been overcome by the use of a low voltage switch movement, one of which is on exhibition at the Coliseum. This machine is designed to operate on 20 volts storage or primary battery and may be controlled from the lever of any kind of interlocking machine or by a simple double throw knife switch.

The control used requires only three wires between the tower and the switch for the control of the switch movement and the three signals that are necessary for the protection of traffic over the switch. The switch cannot be thrown unless all signals are in the full stop position and the track unoccupied. A signal cannot be cleared unless both the switch movement and the relay controlling it are in such a position as to insure safe movement of trains over the route governed by the signal; that is, they obtain complete S. S. control which for a long time has been recognized as one of the safest principles of power interlocking.

An indicator in the tower conveys to the tower man all necessary information in regard to the operation of the switch and signals and indicates the acceptance of a signal by a train or the departure of a train from the section. The switch movement itself is in keeping with very high standards of design, material and workmanship. The motor is rugged in construction and can be left blocked indefinitely without injury on 32 cells of primary battery. This condition might exist in case the switch became jammed in mid-stroke. Another attractive feature is the terminal board near the wire inlet. This feature is common to all of the Union's Model 13A switch movements. With this arrangement all of the internal wiring is done before the movement leaves the factory so that all connection at time of installation is made to terminal posts near the wire inlet.

New Trade Literature

L. M. Booth Co., New York, have recently issued a 16-page illustrated bulletin, S-15, on their Type F Water Softener. The bulletin illustrates a number of installations of Booth Continuous Type Water Softeners, which automatically furnish a complete daily measurement record of the water purified, the chemicals used, etc. The construction and operation of typical plants and the method of determining the proper type of installation is considered.

Chicago Pneumatic Tool Co., Chicago, Ill., have recently issued a four-page bulletin describing the Duntley Universal Electric Hammer Drill, which will operate interchangeably on direct or alternating current. The hammer blow, which is delivered by a piston on the drill or chisel, is produced by pneumatic impact and is very effective. Suitable tools for use in the hammer are also described.

The Columbia Nut & Bolt Co., Bridgeport, Conn., have recently issued a 24-page illustrated booklet describing, in addition to their original Columbia Lock Nut and Improved Columbia Lock Nut, their new Columbia Jib Nut Lock and Kling Bolt. The jib nut lock is a three-thread nut with a bent edge on each side, made either square or hexagon. The Kling bolt has a divided head, which permits the head to be put through a hole the size of the bolt and lock, where only one side of a sheet, to which something must be bolted, is accessible.

The D & A Post Mold Co., Three Rivers, Mich., have issued for the convention an illustrated folder describing the equipment and supplies for manufacturing "D & A" reinforced cement fence posts for railway service.

Thomas A. Edison, Inc., has issued through the Primary a Battery Division, at Bloomfield, N. J., a 20-page illustrated catalogue, No. 3043, on primary cells, renewals and parts, giving, with details of construction and prices, the component parts of primary batteries and battery systems, as well as information on which to base the proper selection of the type of battery best adapted to any given requirements of service.

The Fibre Conduit Co., Orangeburg, N. Y., have recently issued an 84-page illustrated catalogue describing in detail the advantages, construction and installation of Orangeburg fibre conduits.

The Hatfield Rail Joint Manufacturing Co., Macon, Ga., have issued for the convention a 6-page illustrated bulletin on the Hatfield rail joint, rail joint fasteners, and crossing and frog fastenings, which describes the Hatfield method of using high tension heavy coil springs with a vibration bar and reinforced angle bar.

The National Metal Molding Co., Pittsburgh, Pa., have issued an illustrated linen-backed wall chart showing conduit charts as adopted by the National Electrical Contractors' Association, showing sizes of conduit required by the National Electric Code.

T. W. Snow Construction Co., Chicago, Ill., have issued for the convention a four-page illustrated circular on Rivetless Tank Hoop Lugs, which describes lugs for oval and flat hoops, held by two bolts, and which illustrates the types and their applications.

Standard Oil Co. (of Ind.),Chicago, Ill., have recently issued a 16-page booklet dealing with the composition, characteristics and service-giving qualities of their new Fortnite Long Time Burner Oil for signal burners. Some data from tests is included and considerable information in regard to the economy that can be effected both in oil and maintenance labor by the use of this grade of signal oil.

The Track Specialties Co., 29 Broadway, N. Y. City, have recently issued a 16-page booklet containing an article by Wellington B. Lee, M. Am. Soc. C. E., giving simple and accurate rules for the computation of shortened switch leads and some information on the subject of derailers.

Tyler Underground Heating System, Pittsburgh, Pa., have recently issued an architect's and engineer's data sheet containing a number of sectional drawings, diagrams and tables of value in laying out and constructing underground heating systems. The sheet is divided into 61 detail drawings and tables and contains a wealth of valuable information on their system.

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Book Reviews

The Civil Engineer's Pocket Book, by John C. Trautwine, C.E.; revised by John C. Trautwine, Jr., and John C. Trautwine, 3rd, C. Es.; 19th edition; third issue. Published by Trautwine Co., Philadelphia, Pa. Price, $5.

The Trautwine Civil Engineer's Pocket Book holds an old and honorable place in the engineering world. It has grown with the passing years, and now has 1,257 pages of condensed and valuable matter, covering every phase of the requirements of the profession. The books is about 6¾ x 4½ ins., bound in Morocco leather, gilt edge, and is thumb-indexed, so that any one of sixteen subjects can readily be found without practically opening the book. The first edition appeared in 1872. The index at the end of the book is compiled with a view of being thoroughly comprehensive, and embraces 47 pages.

Among the easily found general heads are: The theory of mathematics and geometry, weights and measures, surveying, physics, statics, strength of materials and hydraulics. Practice deals with engineering operations, such as dredging, building, structures, etc. —in short, doing work in the open. The letters W. W. refer to water works, such as dams, reservoirs, pipes, hydrants, etc. Trusses take in bridges of all kinds and neat little line illustrations of bridge types tell this story at a glance. Railroad work is handled exhaustively with tables, illustrations and figures. Material comprises characteristics of iron and steel, shapes, tests, tables, etc. Under the head of costs is an indication of average prices and business directory, in which the various kinds of materials and the representative names of supply houses, a bibliography or list of books intended to be usefully suggestive to the civil engineer closes that department. A very full and complete line of information on the important subject of concrete occupies 126 pages, and is a matter not always to be had in as full and complete form. The matter is necessarily new, as the art is comparatively young and accurate data is not readily accessible.

This brief survey of the work is of course incomplete and fragmentary, as the only real description of the book is the book itself. In the introduction to "Engineer's Field Manual," prepared under the direction of the Chief Engineers, U. S. Army, reference to the book before us is made among the list of authorities. The reference is to "a single work seems to deserve further mention, and that is the incomparable 'Trautwine,' the indebtedness to which is too obvious to require mention, but too important to permit it to be dispensed with." Not only are the formal topics fully treated, but all through information is available which gives internal evidence that the authors have left no stone unturned in their search for full, reliable and authentic evidence of their facts and figures.

Engineering as a Career. This is a series of papers by well-known engineers, and the book has been edited by F. N. Newell, Professor of Civil Engineering in the University of Illinois, and C. E. Draper, Secretary the Cleveland Engineering Society. Published by D. Van Nostrand Co., New York. Price $1.00 net.

This work is a guide for young men and a reference book, as it were, for those of experience. The separate articles, which are short and to the point, are by representative men who have been successful in the engineering field. Frequent requests for such a work is the reason for its publication. It therefore meets a want. It is really a book of experiences, and in each article we see how the writers gained the success which was their original aim. It is an interesting book to have at hand always.

Concrete. By John C. Trautwine, Jr., and John C. Trautwine, 3rd, civil engineers. First Edition, 1916. Trautwine Co., Publishers. Price, $1.00.

This book on concrete is reprinted in convenient form from Trautwine's Civil Engineer's Pocket Book and contains not only the specific part on concrete, but kindred and allied topics from the Pocket Book have been incorporated in "Concrete." Some of these are strength of materials, mortar and cement mortar, experiments, specifications, cost, price list, business directory, bibliography and index. The whole subject of concrete is very fully dealt with, not in the narrative style, divided into chapters, as in ordinary books on the subject, but in the Pocket Book style, and it has been said of this book that it is believed to contain a more complete and more conveniently classified presentation of modern practice in concrete, both plain and reinforced, than is to be found elsewhere in equal space. This book appeals to the engineer who is especially devoted to concrete structures or has concrete work to do on railways. It is a "concrete" pocketbook in condensed and convenient form, and ought to be of great use to the profession

Personal Items for Railroad Men

A. Astle, recently appointed roadmaster of the Moncton and New Castle division of the Intercolonial Railway at New Castle, N. B., entered the service of the Canada Eastern in 1893 as a sectionman. In 1895 he was appointed section foreman and in 1904, when the Canada Eastern was taken over by the Intercolonial Railway, he was put in charge of large gangs making extensive repairs to the road. In 1911 he was appointed roadmaster and remained on that division until has recent appointment, succeeding A. P. Giles, superan-

F. V. Berkey, recently appointed assistant engineer of the Indianapolis Terminal and Vincennes division of the Vandalia Railroad at Indianapolis, entered the service of the Pennsylvania Lines west in 1903 as assistant in the engineering corps in the Logansport division and later served in a similar capacity on other divisions. In 1914 he was appointed assistant division engineer of the Zanesville division from which he was promoted to his present appointment, in which he succeeds H. B. Kester, transferred to the St. Louis division of the Vandalia Railroad.

R. A. Black, recently appointed resident engineer of maintenance district No. 2 of the Canadian Government Railways at Campbellton, N. B., commenced railroad work with the Canadian Northern on their first location service southeast of Winnipeg. In 1898 he was appointed roadmaster on location work for the Canadian Pacific and served in various capacities until his appointment in 1902 as resident engineer of construction. In 109 he was appointed locating engineer for the National Transcontinental Railway. In 1910 he was made division engineer of construction and in 1913 assistant district engineer of District B, which position he held until 1915. In that time he was appointed resident engineer of District No. 5 of the Canadian Government Railways, where he remained until his recent transfer to District No. 2.

S. C. Grizzle, recently appointed roadmaster of the International and Great Northern Railway at Italy, Tex., entered the employ of that road in 1904 as section foreman. In 1905 he was made yard foreman and in 1908 was made extra gang foreman. In 1911 he was made general foreman of the Houston terminals, where he remained until his recent appointment, where he succeeds M. Kerr, who has left railroad service to engage in other business.

A. H. R. Howe, recently appointed division engineer of the Illinois division of the Baltimore and Ohio Railroad at Flora, Ill., entered the service of the Boston and Albany in 1903 and served successively as rodman, level man, inspector and transitman. In 1906 he entered the service of the Baltimore and Ohio in the chief engineer's office and in 1909 entered the government employ on the Isthmus of Panama as chief draughtsman on the Pacific division. In 1911 he took up his work again with the Baltimore and Ohio and later that year was appointed assistant division engineer of the Ohio division. In 1913 he was made division engineer of the Cincinnati Terminal division, and when that division was abolished in 1914 he was appointed master carpenter of the Ohio division, where he remained until in his present appointment he succeeds H. R. Gibson, promoted to the division engineer of the Indiana division. nuated.

William McNab has recently been appointed valuation engineer of the Grand Trunk Railway system at Montreal.

F. J. Meyer has recently been appointed roadmaster of sub-division No. 2 of the main line of the New York, Ontario and Western Railway.

J. S. Patrick, recently appointed roadmaster on the Minneapolis, St. Paul and Sault Ste Marie at Moose Lake, Minn., entered railroad service as a section laborer for his father, who is at present section foreman at Silver Lake, holding the record of 33 years of continual service. In 1910 Mr. Patrick entered the service of this road as assistant foreman and in 1911 was made extra gang foreman in charge of construction on new lines and terminal work, including the track and switch work of the Minneapolis, St. Paul and Sault Ste Marie elevated freight terminal in Chicago in 1913, and the rearranging and enlarging of the track lay-out in the Great Northern station in Minneapolis.

George V. Sneden, engineer maintenance of way of the New York & Long Branch R. R., at Long Branch, N. J., died recently at his home in Red Bank, N. J.

Ross Shaul, recently appointed supervisor of track for the Cleveland, Cincinnati, Chicago and St. Louis Railway, at Springfield, Ohio, had been previous to this promotion extra gang foreman for about three years, and before that timekeeper in the engineering force for some time.

H. E. Stafford, recently appointed general roadmaster of the Duluth, South Shore and Atlantic Railway at Marquette, Mich., was appointed roadmaster on the Nebraska division of the Chicago and Northwestern in 1886 and in 1890 was made roadmaster on the Duluth, South Shore and Atlantic. In 1907 he was appointed assistant superintendent, as the track department on that road was included in the organization of the transportation department. Recently a reorganization has placed the track department under the jurisdiction of the engineering department of the road, the position of assistant superintendent has been abolished and Mr. Stafford has been appointed general roadmaster.

A. O. Swift, recently appointed signal supervisor for the Chicago district of the Chicago, Milwaukee and St. Paul, entered the service of that road in 1898 in the bridge and building department. In 1906 he was transferred to the signal department and in 1909 appointed assistant signal foreman of the Chicago district. In 1910 he was appointed district signal foreman for the Chicago district, and when the Chicago district was recently made a supervisor district Mr. Swift was appointed signal supervisor.

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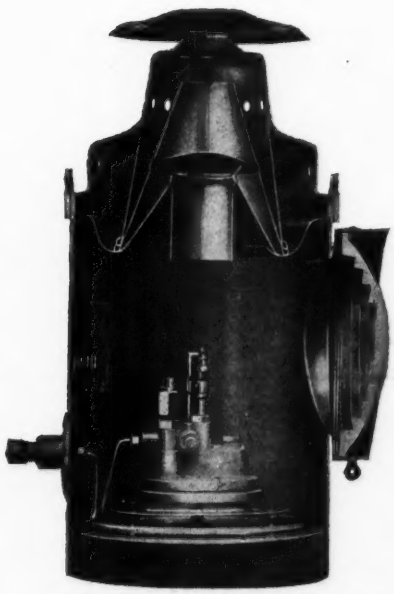

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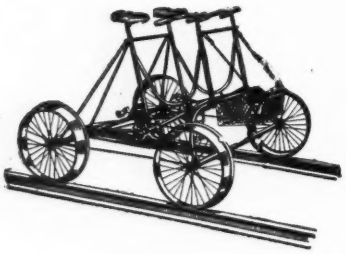

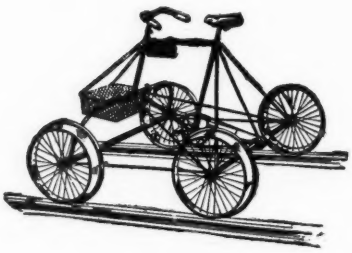

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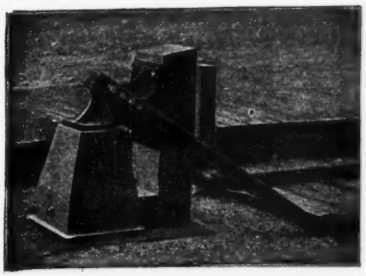

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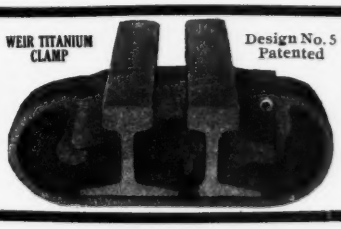

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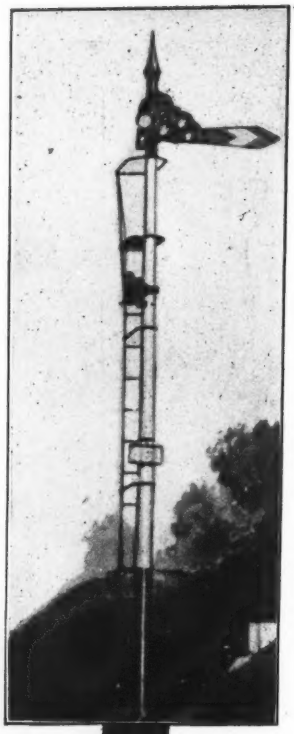

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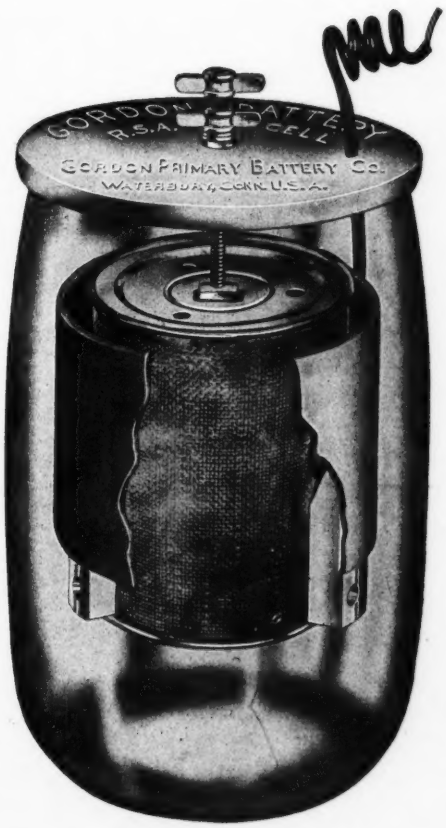

Study them and find out if the cells you are now using live up to them.

GORDON R. S. A. CELLS

guarantee these essential features and have passed every comparative test. Every detail of construction in the Gordon cell is worked out with the utmost care.

Gordon R. S. A. Cells are unexcelled for efficiency and economy.

They ought to be included in your "standards."

Prominent railroads are using them to their utmost satisfaction.

Insist upon proof. ***Install a set.***

Gordon Primary Battery Co.

General Office and Factory

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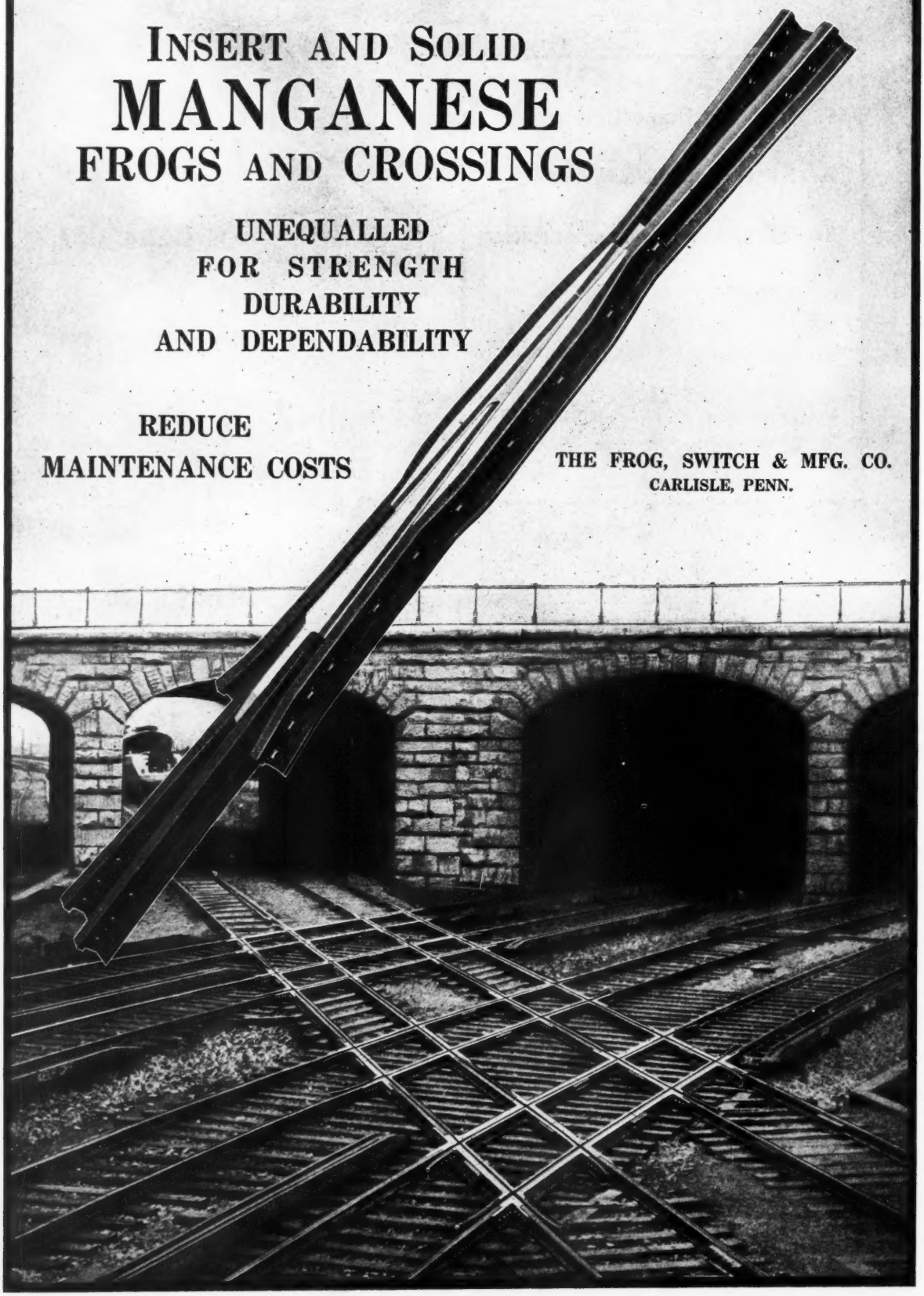
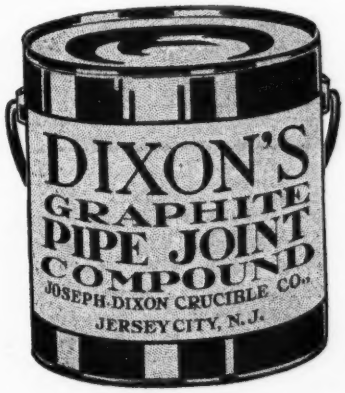
MANGANESE
FROGS AND CROSSINGS

UNEQUALLED
FOR STRENGTH
DURABILITY
AND DEPENDABILITY

REDUCE
MAINTENANCE COSTS

THE FROG, SWITCH & MFG. CO.
CARLISLE, PENN.





Dixon's Graphite Pipe Joint Compound

Hard-set pipe joints and fittings are impossible where this compound is used, because it never hardens or sets. The graphite prevents rust and corrosion—and it is easy at any time to unscrew a joint.

At the same time an absolutely tight joint can be secured and maintained. Send for a sample and try it on any screwed or flanged joint, and on studs and bolts. Ask for a copy of "Valuable Graphite Products," No. 187-D.

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Established 1827

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Mailing date: Ninth of each month. Advertising copy and cuts must be in hand on the thirtieth of previous month, if proofs are to be submitted; not more than three days later—the third—if proofs are *not* required.

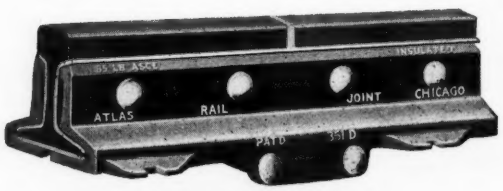
Atlas Rail Joints, Braces and Tie Plates

ATLAS COMPROMISE OR STEP JOINTS

Atlas Standard Compromise Joint No. 1

Atlas Compromise Joint No. 9

We have over 800 different Step Joint patterns and can connect any style of rails.



Atlas Insulated Joint No. 1

Our Insulated Joints Require Few Renewals

ATLAS TIE PLATES and BRACES

Atlas Primer and Surfacer for your Cars

Atlas Railway Supply Co.

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Eastern Branch:
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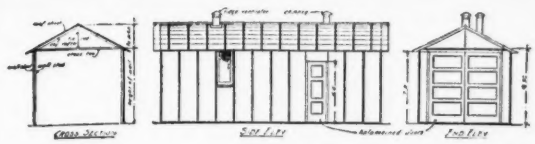

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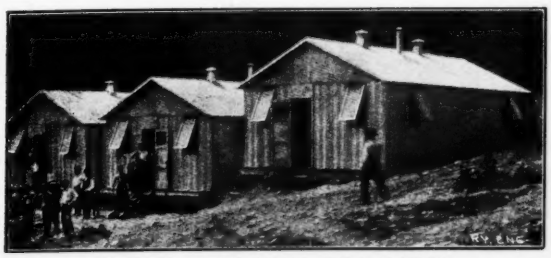

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Station "C." **BALTIMORE, MD.**

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As Long as the Life of the Pipe in the Well Goes with the

BAKER AIR INJECTOR SYSTEM

Baker Air Injector at Work

No Pulling of Wells.
No Trouble from Sand or Gravel.
Purity of Water Assured.

That's the **Baker Air Injector System**

Operated by

"Chicago Pneumatic" Compressors

If you are not getting the amount of water you need, or if you are not getting the amount you expected to get in the old air lift way, or from your sucker rod and plunger pumps, communicate with us. We have an interesting proposition for you.

Water Lift Dept.

CHICAGO PNEUMATIC TOOL CO.

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BRANCHES EVERYWHERE

"ARMS AND THE MAN"

All that is needed back of

HUBBARD TRACK TOOLS

is a husky laborer, ready to do a full day's work.

Such a combination makes for the betterment of roadbeds, at the LOWEST UPKEEP COST.

HUBBARD & CO.

Pittsburgh, Pa.

Reconstruction of piers and abutments, Boston & Albany Railway Bridge

LUCIUS ENGINEERING CO.,

HARTJE BUILDING, FIRST AVENUE AND WOOD STREET

Bell Phone, Court 3524

PITTSBURGH, PA.

NEW YORK OFFICE, 607 POTTER BUILDING

Boston & Albany R. R. Bridge, Worcester, Mass.

Points of Merit of the Indianapolis R-N-R Frogs

No. 1. Requires no renewals or removing during life of Manganese.

No. 2. Minimum length of solid Manganese Frogs.

No. 3. Full length track rails fit into recesses of Frog, making all joints self-contained.

No. 4. Cost, maintenance and use of three pairs of splices eliminated.

No. 5. Perfectly foot guarded at heel, toe and flares, meeting all requirements of all railroad commissions.

No. 6. Clamping toe plate gives uniform bearing to base of rail, re-enforces the easer extensions and absorbs all outward thrust strains.

No. 7. Adjustable wedge block at toe keeps rails tight, preventing flange interference.

No. 8. Easement at heel and toe protecting rail ends, eliminating joint impact.

No. 9. Wing rail easers continuous, protecting point and eliminating wear from worn teirs at throat.

No. 10. Design admits of a standard and fixed dimension for a given NUMBER and rail section, uniform for all roads.

Points of Merit of Solid Manganese Frogs in General

The following points of ECONOMY, ADVANTAGE and MERIT compared with ordinary bolted or manganese insert bolted frogs apply to the various types and forms IN GENERAL of solid manganese cast construction.

No. 1. Integral, no separate members to work loose, requiring constant maintenance.

No. 2. One-piece construction reduces chance of derailment through broken or misplaced parts as in fabricated work.

No. 3. One-piece frogs maintain alignment and throat-ways.

No. 4. Genuine Manganese Steel gives several times the wear of Bessemer or Open Hearth.

No. 5. When worn down at points of severe service, can be refaced by Electric Welding and resurfaced.

No. 6. Will withstand damage of Derailments.

No. 7. Cast from pattern, ends can conform to foreign section without compromise.

No. 8. Self-contained structures conserve tie system.

No. 9. Solid Manganese Frogs properly designed and of genuine material show greater strength and larger safety factor than built up construction.

No. 10 Solid one-piece construction is not affected by the elements and does not deteriorate as rapidly through wear as the component parts of assembled structures.

The Indianapolis Switch & Frog Co., Springfield, Ohio